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A Possible Celestial Catastrophe.

By J. E. GORE, F.R.A.S.

IN the Second Epistle of St. Peter there is a prediction of the destruction of the world by fire. It is a matter of some uncertainty whether this epistle was really written by the apostle Peter. There are no certain traces of it earlier than the 3rd century. Its authenticity was questioned by Origen, and St. Jerome says that many in his time rejected it. The difference in style between the first and second epistle is so marked that modern critics think it improbable that the second epistle was written by St. Peter. But there is "no consensus of opinion against it," and as it is now universally admitted into the canon of Scripture we may, perhaps, accept it as genuine. However this may be, it seems remarkable that in the great Sanscrit epic poem, the "Mahabharata," there is a distinct prediction of the destruction of the world by fire. In that ancient work, the following passage occurs:* "O King, towards the end of those thousands of years, constituting the four *Yugas*, and when the lives of men become very short, a drought occurs extending for many years. And then, O Lord of the Earth, men and creatures, endued with small strength and vitality, becoming hungry, die by thousands. And then, O Lord of men, seven blazing suns, appearing in the firmament, drink up all the waters of the earth that are in the rivers or seas. And, O bull of the Bharata race, then also everything of the nature of wood and grass that is wet or dry is consumed and reduced to ashes. And then, O Bharata, the fire called *Samvartaka*, impelled by the winds, appeareth on the earth that hath already been dried to cinders by the seven suns. And then that fire, penetrating through the earth, and making its appearance in the nether regions also, begetteth great terror in the hearts of the gods, the *Danavas* and the *Yakshas*. And, O Lord of the Earth, consuming the nether regions, as also everything upon this earth, that fire destroyeth all things in a moment," etc. This agrees with St. Peter's words, "The elements shall melt with fervent heat, the earth also and the works that are therein shall be burned up." The idea of "seven suns" in the above extract is also in curious agreement with the words of the prophet Isaiah (chap. 30, v. 26), "Moreover, the light of the moon shall be as the light of the sun, and the light of the sun shall be sevenfold as the light of seven days in the day that the Lord bindeth up the breach of his people, and healeth the stroke of their wound." Assuming the truth of these remarkable predictions, let us see how the catastrophe of a general conflagration might be brought about by the operation of natural causes without the intervention of a miracle.

Some have supposed that such a catastrophe might possibly be produced by an outburst of the internal fires of the earth. But such an hypothesis—in itself very improbable in a cooling globe like the earth—is directly opposed to St. Peter's words. He says: "The heavens,* being on fire, shall be dissolved," clearly indicating, I think, that the fire is to come from the *outside*; "the heavens," not the earth, being on fire, is to be the immediate cause of the catastrophe. Others have thought that an outburst in the sun would, perhaps, produce the conflagration, and this certainly seems much more probable. Were the sun to suddenly blaze up, like the "temporary stars," recorded in the annals of astronomy, and of which we had such a brilliant example in February, 1901, in Perseus, then, of course, the earth would certainly be burnt up, and at least everything on its surface would at once be reduced to ashes. But, although this is, of course, within the bounds of possibility, such a catastrophe is not, I think, at all probable. There are, to be sure, small outbursts daily taking place in our central luminary, as indicated by the "prominences," or red flames, visible

* From an English translation of the *Vana Parva*, by Pratap Chandra Ray, C.I.E. Second Edition, 1889, p. 561.

* Here the word "heavens" means the earth's atmosphere.

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round the sun's limb during total eclipses; but these are of comparatively small importance, and not likely at any time to endanger the earth's safety. An outburst on a much larger scale would be necessary to produce anything in the way of a catastrophe which would destroy all life on our terrestrial abode.

Now is there any cause which would produce a great outburst of light and heat in the sun? I think we have such a cause in the possible collision of the sun with a dark body in space. The distance of the stars is so great, that the collision of the sun with a *star* is a contingency which may be at once dismissed. Such an event, if it ever took place, could not possibly happen for thousands of years to come. To pass over the distance which separates the sun from even the *nearest* fixed star would take, at the rate of, say, 10 miles a second, about 80,000 years!

The existence of dark bodies in space has been suspected by astronomers. I say suspected, for really we have no *direct* evidence that such bodies exist. The idea seems to have originated in the so-called "dark companion" of the variable star Algol. But we have no evidence whatever that Algol's companion is really a "dark body," that is, a body devoid of all inherent light of its own, like the earth. It is true that in the case of Algol the spectroscope shows no sign of a second spectrum, as in some variables of the Algol type in which both components are of nearly equal brightness. But it has been recently found by Professor Hartmann that "a difference of only about one magnitude would be sufficient to bring the spectrum of the fainter component to almost complete disappearance, and a difference of two magnitudes would make it impossible for even a trace of the fainter spectrum to be visible on the plate." * The companion of Algol might, therefore, be of the 4½ or 5th magnitude, and neither telescope nor spectroscope would show any sign of its existence. But, apart from the above considerations, it seems very probable that many dark bodies do exist in space. In the case of large bodies of this kind, they would have their origin in cooled down suns. Stars cannot go on shining for ever. They commence their course with a limited amount of potential energy, and this energy is being incessantly dissipated in the form of radiant light and heat. This dissipation of energy cannot clearly go on continually, and in the course of ages must become exhausted. It is like a man living on his capital. If he receives no interest on it, and goes on spending the money steadily, the day must come, sooner or later, when the capital will disappear, and the man will be reduced to a state of bankruptcy. So it is with a sun. It can receive no energy from without, and it is constantly wasting its capital of energy in the radiation of heat and light. It is true that this waste may be apparently compensated for a time by the contraction of the sun's mass due to gravity. But this is only the conversion of potential energy into heat, and eventually the process must cease, as after a time—counted, of course, by ages—the sun's density will become so great that the contraction will cease, owing to the overcrowding of the molecules, no further heat will be produced, and the body will begin to cool down. When this cooling process has sufficiently advanced, the sun will lose its light, and "roll through space a cold and dark ball." There is evidence to show that in some of the long-period variable stars, this permanent waning of light has already commenced, and it seems highly probable that, in many cases, the "cold and dark" stage has been actually reached. These dark bodies may, indeed, be very numerous, but we have no means of observing them, as they show no light, and would not be visible, even as faint stars, by the largest telescopes which could ever be constructed.

It is now well known that the sun is moving through space with a considerable velocity, and, of course, carrying with it the earth, and all the planets and satellites of the solar system. Various estimates have been made of the point towards which the sun is moving, but the most recent and accurate calculations seem to point to a spot near the bright star Vega (α Lyræ). In its flight through space it seems quite within the bounds of possibility that the sun may some day come into collision with a dark body. Should such an event occur, the collision would, of course, produce an enormous amount of heat and light, and St. Peter's prediction would at once be fulfilled. "The heavens" would be "on fire," and the whole surface of the earth, and everything on it, would be reduced to cinders in a few minutes. It would be like the destruction of St. Pierre on a colossal scale. The world would end

"In unremorseful folds of rolling fire."*

But such a catastrophe could not occur without our knowing of the coming disaster months, and perhaps years, beforehand. When the approaching dark body came within a certain distance of the sun it would begin to shine by reflected light, like the planets. If a very large body, comparable with the sun itself in size, it would first become visible far beyond the confines of the solar system. For some months, or years, its motion would be very slow, owing to its great distance from the sun. It would probably be first discovered as a telescopic star, not differing in appearance from other stars of the same brightness in its vicinity. It would then, perhaps, shine as a star of about the 9th magnitude, as any much fainter star would probably be overlooked. Doubtless it would at first be mistaken for a "new" or "temporary star," or a variable star at its maximum brightness; but the comparative constancy of its light, and its great parallax, or apparent change of place among the neighbouring stars, would soon reveal its true character, and show that it was really near the earth compared with the distance of the stars. It might, however, be mistaken for a distant comet, but if coming directly towards the sun, its change of place would be small, and its light examined with the spectroscope would show a solar spectrum, indicating that, like the planets, it was shining by reflected sunlight. Further, its distance could be calculated from its parallax, and the result would show that no comet would be visible at such a distance from the sun.

I have made some calculations on the motion of this hypothetical body after it became visible as a star of the 9th magnitude, and, therefore, easily visible in a telescope of three inches aperture. Let us suppose the approaching dark body to have the same mass as the sun and the same density as the earth. Taking the earth's density as four times that of the sun, and the sun's diameter as 866,000 miles, I find that the diameter of the dark body would be about 546,000 miles. Now, taking the diameter of Uranus as 33,000 miles, its stellar magnitude as 5.7, and assuming that the dark

* *Astrophysical Journal*, May, 1904.

* Tennyson, *The Holy Grail*.

body has the same "albedo," or light-reflecting power, as Uranus, I find that the dark body would shine as a star of the 9th magnitude when at a distance from the sun of 8.68 times the distance of Uranus, or about 15,000 millions of miles. Further, assuming that the sun is moving through space at the rate of 11 miles a second (about its probable value), and that the dark body is moving directly towards the sun with the same velocity, we can calculate by the laws of Dynamics the time taken by the two bodies to come together, starting with a distance between them of 15,000 millions of miles. The motion for the first few years would be comparatively slow, and, as I have said, the increase in brightness of the dark body would at first be imperceptible. To reduce the distance to 12,000 millions of miles would, I find, take about 3.4 years. At the end of 6.7 years the distance would be reduced to about 9,000 millions of miles, and in 9.8 years to about 6,000 millions. At this distance the brightness of the dark body would increase to about the 5th magnitude, and it would then be distinctly visible to the naked eye. In about 11.8 years the distance would be reduced to 4,000 millions, and in about 14 years the dark body would reach the orbit of Uranus, or, rather, it would be at the same distance from us as Uranus, for its path would not intersect the orbit of the planet, as I will show presently. It would then shine as a star of about —0.4 magnitude, or a little brighter than Arcturus, and would, of course, attract general attention. After this its distance would rapidly diminish, and its light quickly increase. After about a year from this time it would reach the distance of Jupiter. Its light would then be greatly increased. It would appear as a star of about—6½ magnitude, or about 4 magnitudes brighter than Jupiter at its brightest, and about 2 magnitudes brighter than Venus at her greatest brilliancy. It would then be the brightest object in the heavens, with the exception of the moon, and would be the "observed of all observers." After this its motion would become very rapid, and in about 51 days it would be at about the same distance from the sun that the earth is. From this point my calculations show that the velocity would be very rapid, and if a direct collision took place the sun and dark body would meet in about eight days, the velocity of each body being then over 400 miles a second! The effects of such a collision may be easily imagined. Both bodies would be reduced to the gaseous state within an hour, and a stupendous amount of heat would be produced—heat sufficient not only to destroy the earth, but probably most of the planets of the solar system.

If the dark body approached the sun in a straight line, it could not strike the earth itself or any of the planets, for the direction of the sun's motion in space is inclined to the plane of the earth's orbit at an angle of about 60 degrees. The nearest approach of the dark body to the earth would depend on the time of year at which its collision with the sun took place. If this occurred about the end of December the dark body would not approach the earth nearer than the sun's distance, but if the collision took place about June 21st I find that the body would approach the earth within about 80 millions of miles. In the latter case its attraction on the earth would be greater than that of the sun, and it would probably draw the earth out of its orbit. In either case, when the collision took place, the sun's mass would be suddenly doubled, and, according to Professor Young, the earth's orbit "would immediately become an eccentric ellipse, with its aphelion near the point where the earth was when it occurred."* But of course this alteration in the earth's orbit would not concern humanity after the earth, and all its inhabitants, had been reduced to ashes.

It is, of course, possible that the dark body would not approach the sun directly in a straight line, but along an elongated ellipse. In this case it would miss striking the sun, and there would be no collision. But the earth's motion in its orbit would be much disturbed by the powerful attraction of the dark body, and it is not easy to determine what the exact result would be. If, however, the body were moving in a sufficiently elongated ellipse to pass inside the earth's orbit, it would probably pass close enough to the sun to produce a great disturbance in that body, due to tidal action, and a large amount of extra heat would probably be developed. Should the two bodies merely graze each other, an enormous amount of heat would certainly be produced, quite sufficient to cause the earth's destruction.

The approach of the dark body to the sun would form a magnificent celestial spectacle. When it arrived within the sun's distance from the earth it would, I find, shine with about the same brightness as the moon when full, but with a smaller diameter, and it would rapidly increase in brightness of surface as it approached the sun. It would then—especially if the approach occurred in the month of June—begin to show phases like the moon, and we should have the curious spectacle of two moons in the sky, one somewhat smaller than the other!

Instead of a dark body of the mass of the sun, we may suppose one very much smaller, say of the size of Jupiter. In this case, the masses being so unequal, the sun's motion would be much smaller. On the other hand, the dark body would not become visible until it was much nearer to the earth. In the case of a body like Jupiter, say 87,000 miles in diameter, I find that it would become visible as a star of the 9th magnitude at a distance of about 3½ times the distance of Uranus from the sun, or about 6,000 millions of miles from the earth. If the diameter of the dark body was the same as that of the earth, it would shine as a star of the 9th magnitude at about the distance of Uranus, and in this case it would fall into the sun in about three years. The amount of heat produced by the collision would, of course, be very much smaller than in the cases just considered, but it seems very probable that even a body the size of the earth, moving with such a high velocity, when it struck the sun would produce the most disastrous results to the earth. Such a body may possibly be now approaching us. If only the size of the earth, it might easily escape detection until well within the orbit of Uranus, and we might then have only a few months' warning before the final catastrophe occurred.

But, it may be asked, is there any star visible at present which might be identical with an approaching dark body? Well, all I can say is, that I have carefully examined the region round Vega with a powerful binocular field glass, and that at present (April, 1905) there is no star brighter than the 7th magnitude within five degrees of Vega, which is not perfectly well known to astronomers. A careful examination with a 3-in. telescope, or, better still, a photograph of the region would be necessary before a decided opinion could be formed on the subject.

* *Manual of Astronomy*, p 294.

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Influenza and the Weather.

By ARTHUR H. BELL.

SCAPEGOATS are always in fashion, for at all times people have shown a strong tendency to put the blame for the ills to which humanity is heir on something or somebody. The bills of mortality, for instance, as soon as ever winter comes grow enormously long, and in looking round for an explanation of this unusual increase it seems the most natural thing in the world to set down the ills of the community to the account of the weather. Influenza, especially, is thus ascribed to the vagaries and pranks of the British climate, but an examination of the facts gives but little support to this popular belief, and it may, indeed, be shown that the scapegoat on this occasion is burdened with misdeeds from which it should properly be free.

The particular variety of the British climate summed up under the heading East Wind has, for example, more particularly been objurgated and anathematised as a breeder of the influenza; but since meteorologists have been studying the anatomy and character, so to speak, of this much maligned wind they have come to the conclusion that the advantages derived by its beneficent action on the land are to be counted as a set-off against its undoubted untoward effects on man and beast. The East Wind, among other good deeds, extracts all the moisture from those land surfaces over which it blows, and so breaks up the soil and puts it in better condition for the sowing of seed, and in this way large tracks of country are, from an agricultural point of view, improved and brought into good condition. This wind it is that breaks up the soil and pulverises it, this beneficent action being recognized by the old proverb that says, "A peck of March is worth a King's ransom."

In passing it may be said that the East Wind, which, like the Gulf Stream, may almost be called a national institution, is, however, mainly to blame for chapped hands and reddened and roughened cheeks so much in evidence when this wind is streaming through the air. That it has these effects on the human cuticle is due to the fact of its being a dry wind. All the moisture, indeed, is taken from it as it journeys across the frozen plains of Northern Europe, so that notwithstanding its subsequent journey across the North Sea it is still very dry by the time it reaches the British Isles. As a result it sucks up water wherever it is to be found, and, as already mentioned, it is from the land that it takes much of the moisture wherewith it quenches the thirst induced by its long journey. But like so many other surfaces the skin of human beings is constantly giving off moisture, and as the thirsty wind comes along it promptly avails itself of these stores wherever it finds a hand or a cheek exposed to it.

Moreover, it is well known that according as there is little or much vapour in the air, so is the passage through the atmosphere of the heat from the sun assisted or retarded. Bearing this elementary fact in mind it will be understood that since the air is very dry when the East Wind is blowing, the sun's rays readily pass through the air, and hence arises the redness imparted to hands and faces on cold and frosty mornings. Those who have been on the snow on the top of high mountains will readily call to mind the way in which their skin was reddened by the sunshine as it came uninterruptedly through the cold air. The whole of the blame, therefore, for red noses, chilblains, and chapped hands is not rightly to be given to the East Wind, for the sun also bears much of the responsibility. But the influenza in the popular mind is so intimately associated with chapped hands that it seems a ready way out of the difficulty to say that the East Wind is to blame for both. This aspersion on its character has, however, never been proved, and until a stronger case is made out the East Wind ought not to be used as a scapegoat.

As a matter of fact, climatic conditions appear to have only a secondary effect upon visitations of the influenza epidemic. It seems, indeed, to visit the regions round the Poles as impartially as it does those at the Equator, and the Hottentot and the Esquimaux may, as it were, be said to sneeze in unison. Sunshine would seem to have as little to do with its comings and goings as does the dampness or dryness of the air. The records from the rain-gauge and the hygrometer have, from this point of view, been compared with the statistics of the influenza scourge, and when this is done no agreement is found between them. Meteorologists, moreover, now know that different types of weather are associated with two forms of distribution of atmospheric pressure, one of these forms being called cyclonic and the other anticyclonic. With the cyclones the winds are circling strongly upwards and the weather is stormy, rainy, and altogether unpleasant. In the anticyclones, on the other hand, the winds are circling downwards from the empyrean, and they bring halcyon days and bright, exhilarating, cheerful weather.

Now there was once a theory which informed a suffering humanity that their sneezes and wheezes were due to the fact that the influenza germs were generated by hundreds of dead Chinamen drowned in one of those disastrous floods which so frequently occur when the mighty rivers in the celestial empire overflow their banks. The meteorological data, however, proved very conclusively that the wind over these areas blows very regularly in quite the contrary direction necessary to carry the influenza germs to Europe; and those who wished to throw blame on the wind and the weather had accordingly to cast around for another theory.

The new statement of the case asserted that the influenza was provoked by the dust thrown out by volcanoes, and in one particular year it was confidently ascribed to the tremendous volcanic eruption which occurred at Krakatoa in the Straits of Sunda. During this memorable leaping forth of the subterranean fires the quantity of dust thrown into the air was undoubtedly very great. Moreover, all those beautiful sunsets, after-glows, lunar and solar coronæ, and haloes seen in abundance at this period were allowably to be attributed to this great cataclysm, and since, moreover, influenza was very prevalent just at that time, nothing was easier than to assign its presence to this volcanic outburst in South-East Asia. At this time also, as shown by the meteorological charts, anticyclonic conditions prevailed over the British Islands,

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and since, as already mentioned, the breeze would then be descending from above, the theorists maintained that everything was favourable for the conveyance of the hypothetical germs to the bronchial apparatus of a susceptible humanity. But this method of inducing influenza is something similar to the process of burning down a house in order to procure roast pig. Influenza germs may, unfortunately, be sown without such a display of molecular energy as occurred at Krakatoa, and volcanoes therefore played the part of scapegoat during but a short time. Pumice stone as a suggested source of influenza has, notwithstanding the recent volcanic purturbations, therefore, been abandoned.

Now the great objection to all these theories which demonstrate how the influenza is wafted about by the breezes is found in the fact that people in isolated positions escape the scourge. For instance, lighthouse-keepers, the inhabitants of certain islands, and people on board ships that do not touch land during lengthened periods are not attacked, which they would hardly fail to be were the influenza floating about in the air promiscuously. Prisoners are, as a body, remarkably free from visitations of the epidemic, and serve as a modern instance to disprove the assertion that the weather is at fault. From this point of view it would appear that the best method by which to escape influenza is to break one of the laws of one's country and so secure a moderate period of solitary and isolated confinement.

What seems clear is that the influenza travels from place to place much more quickly than was the case in former years, so that an outbreak say, in Buda Pesth, rapidly journeys to London. As facilities of travel have increased by rail, road, and river, so have the peregrinations of the epidemic been correspondingly accelerated. Investigations indicate very unmistakably that where the stream of travelling humanity is greatest there also is influenza most easily disseminated. It is near the towns that microbes, bacilli, and other objectionable things have their birth, and although the state of the atmosphere may at times be favourable for their transportation, long journeys through the air are fatal to them, for the sun and the wind rob them of their venom. "No climate in the world," said King Charles, "invites a man to walk abroad so many days in the year as the climate of England," and despite the popular impression concerning influenza and the weather, a walk along some country road, or over some wind-filled moor or common is, after all, the surest way to reduce the proportions of the doctor's bill.

As already remarked, different types of weather are associated with anticyclonic or cyclonic conditions, and as regards the latter class of atmospheric vortices, it is possible to trace the track or route they pursue as they journey across the country, the history of their travels being nowadays recorded in the meteorological weather charts. Commonly these storms cross the British Isles in a north-easterly direction, a favourite line of travel being by way of the Caledonian Canal. Now the path taken by the influenza as it passes from town to town bears no sort of relation to the track of the cyclones, which are the chief breeders of damp, cold, windy and rainy weather, and a contemplation of this fact gives no colour to the notion that influenza flies as an arrow by day on the wings of the wind. It is, indeed, not in protecting one's self from the health-giving winds that influenza is to be averted, but rather by a frequent overhauling of the dust-bin, and by taking, as often as possible, a course of sun-baths.

Abnormal Foliage of Sycamore Seedling.

By GRAHAM BOTT, F.L.S.

THE accompanying illustration (Fig. 1) shows a rare abnormal growth of the first pair of foliage leaves of a Sycamore seedling. It will be noticed that complete fusion of the petioles has taken place, and that this fusion has extended to the leaves themselves along the lower two-thirds of their margins, thus forming twin leaves. When compared with a normal seedling (Fig. 2), the anomalous condition is strikingly noticeable; and, since growth proceeds from the angle formed by the leaf-stalks, it is interesting to speculate as to what would have happened in the abnormal form, with reference to further development, had growth been

Fig. 1.—A Sycamore Seedling showing twin leaves (natural size).

allowed to continue; axillary orientation having been arrested by the union referred to above.

It is, of course, recognised that several plants exhibit cohesion of the margins of their leaves as a fixed character, and, according to the degree of union, designated by various terms. But it may not be quite so familiar that many leaves of the same plant show interesting transitional conditions from the simple form through variously lobed (connate), up to the completely-divided compound leaf, such as may be found on the Blackberry (*Rubus fruticosus*) and Cinquefoil (*Potentilla reptans*). Partial union is observed readily, also, between the terminal and one of the lateral leaflets of the Ash (*Fraxinus excelsior*). And a similar fusion of the leaflets of the Scarlet Bean (*Phaseolus*) occasionally occurs, thus transforming the compound leaf into a simple one.

However, those instances are considered as reversion to type, and it is strong presumptive evidence of the evolution of the compound leaf from a simple form.

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But the peculiar instance of the twin leaves illustrated can scarcely be explained on the above lines, and, although it is often impossible to penetrate Nature's mysterious influences determining changes of form, nevertheless, the following explanation is suggested.

Lack of moisture, followed by excessive supply, causes, on the one hand, an arrest of development, and, on the other, rapid growth. Retarded growth favours fusion, and (in the case of a floral member, at least) a symmetrical condition is brought about by an abundant supply of nutriment. Pressure on the growing point would, probably, play an important part also in causing fusion, owing to the delicate nature of the primary tissue.

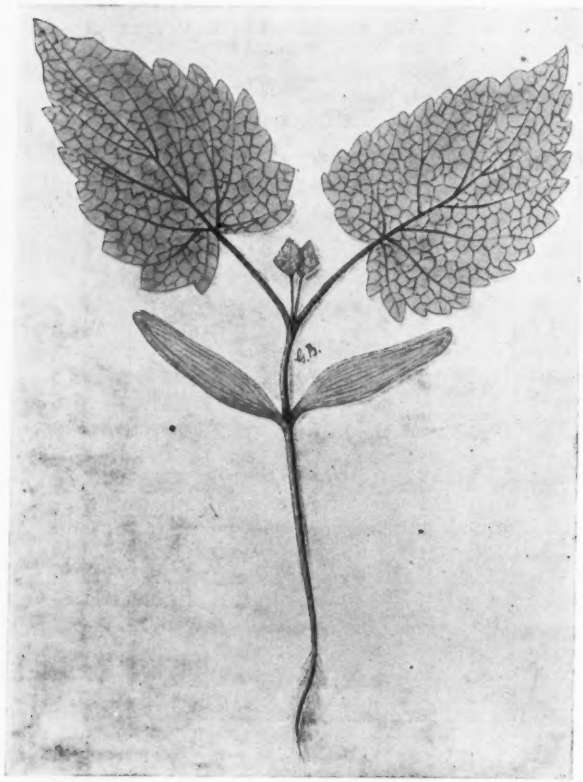

Fig. 2.—Normal Sycamore Seedling (two-thirds natural size).

Now, when the circumstances are considered in which the present specimen grew, it is found that all the above conditions were fulfilled. It is, therefore, reasonable to suppose that the above explanation is the correct one.

It will be observed that both cotyledons are present, otherwise the suppression of one might have been a determining factor in producing the irregular seedling. The specimen was found, by the author, growing on a gravel path near a stone wall, on the south side, during a dry spring, followed by a wet summer. Thus the fact of its adverse environment and irregular nourishment resulted in the inability of the young tissue to work out its hereditary inclination, or to follow that mysterious ancestral impression which has determined all forms throughout the countless æons of the past.

What is Scent?

By DR. J. G. MCPHERSON, F.R.S.E.

A DICTIONARY will say that "scent is that which, issuing from a body, affects the olfactory nerves of animals." But that is not a complete definition. For the issuing source of the scent may be solid or gaseous. Until very recently it was assumed that there were solid particles of the perfuming body to produce the effect.

And certainly that theory has unduly startled thinking people as to the extraordinary divisibility of matter. We are faced by very startling facts; but it is a stretch of the imagination to account for them by the ordinary matter-divisible theory. The tenth part of a grain of musk will continue for years to fill a room with its odour, and at the end of that time will not be appreciably diminished in weight by the finest balance. So acute is the sense of smell in some trained men that one part of prussic acid can be detected in about two million parts of water; and it has no decided smell, only a strange fustiness.

The faculty of scent is very acute in certain insects. If a virgin female of the moth known as *Saturnia Carpini* is shut up in a box, males of the same species will trace her out for a mile through the parti-odoured air of a wood. The infinitesimal emanation from the female is powerful enough to direct the male all that distance. All are familiar with the remarkable scent of the condor for carrion in Eastern countries, but the scent of dogs seems to eclipse all in its marvellous effects.

For ages it was considered certain that the musk and other scents exist in the air after they leave their visible form in solid particles. Now, Dr. John Aitken, F.R.S., has, by experiments, proved that these pass off as a gas or vapour. He has principally employed his well-known cloudy-condensation test. If the musk is in solid particles, these particles will become nuclei of cloudy condensation in super-saturated air, and thus make their presence visible. But this is not the case.

As to cloudy formation in general; ocular demonstration can easily testify to it. If two closed glass receivers be placed beside each other, the one containing ordinary air, and the other filtered air (that is air deprived of its dust, by being driven through cotton-wool), and if jets of steam be successively introduced into these, a strange effect is noticed. In the vessel containing common air, the steam will be seen rising in a dense cloud, but in the vessel containing the filtered air, the steam is not seen at all. Dust-particles are necessary in the air to allow vapour-condensation on the free surfaces, so as to form cloud-particles.

Dr. Aitken has given us a simple method of showing that the solid particles in the air seem to have a lower limit to their size, but that they are never so small as to be capable of diffusing or not being separated but by the action of gravitation. If a glass flask containing common air be provided with an india-rubber stopper, which has two apertures in it, in which are fitted two tubes, one of these tubes is connected with an air pump, and the other with a cotton-wool filter, a stop-cock being introduced in the latter. A little water is put in the flask to moisten the air. If the stop-cock is closed and the pump-handle is pulled out a very short length, cloudy condensation at once takes place, the very smallest expansion being sufficient to

cause the dust nuclei in the air to become centres of condensation, and that is the case even with the very smallest dust-particles.

If part of the cotton-wool be taken out of the filter and only enough be left to keep back all but a few particles, and these of the very smallest size, yet these require but the very slightest expansion to make them visible. If the process of successive expansions be continued, no further condensation is observable.

Now, introduce a little musk into the flask. If the musk gives off solid particles, cloudy condensation would at once take place when the air is expanded by drawing the handle of the air-pump, because the musk would keep up a constant supply of nuclei of condensation. But it is found that instead of that, the condensation is scarcely visible at first, and finally ceases, as if no musk were present at all. In consequence, it is determined that musk does not give off solid particles.

Varying this experiment, Dr. Aitken considered that, if musk passes into the air as a gas or vapour, it would be able to pass through a quantity of cotton-wool sufficient to stop all dust-particles. He first passed air over the musk, then through the cotton filter, with the result that the perfume came freely through the cotton-wool. Some of the gas which first entered the filter was trapped and held by the wool, but the wool soon became sufficiently saturated to allow the musk-vapour to pass. The trapped vapour remained in the wool and could easily be detected afterwards.

He also tested other odorous solid substances by the same simple apparatus, such as camphor and naphthalene. These both acted like musk and gave no nuclei of condensation, and the gas or vapour from both passed easily through cotton-wool. It is, therefore, safely concluded that they, like musk, evaporate in gaseous form. Quite conclusively, Dr. Aitken has similarly tested twenty-three substances; not one of them gave off their perfume in solid particles, nothing but gases or vapours escaping from them.

By repeated experiments, Dr. Aitken has come to a remarkable conclusion, which will be interesting to sanitarians, viz., that sewage does not communicate to the air any solid particles. The offensive emanation is a gas. The air in sewers is remarkably free from germs of all kinds, as they do not leave the sewage. If sewage gave off solid or liquid particles, these also would soon settle on the surface of the sewage. If, however, it be made to flow rapidly over falls, then both germs and particles of the sewage get mixed up with the air, but when the sewage flows without break in its surface film, the offensive emanation is in the form of a gas.

This revolutionary theory will take some trouble to crush. And it will in future save the sensitive feelings of those who have been unduly puzzled with the extreme division theory of matter in the case of conveying scent from the perfumed body.

Star Maps.

WE regret that, at the last, it is not possible to bring out a star map supplement for this number. Not satisfied with the results of the process hitherto employed, we have been testing new methods, which, it is hoped, will give much better results. The trials, however, have not been completed in time for this month, although we hope with the December issue to continue the series.

Sugar.

BY DR. F. MOLLWO PERKIN.

ALTHOUGH the sweetness of most fruits is attributable to their sugar content, there are comparatively few which contain *saccharose*, the sugar which, in this country, is generally called *cane sugar*. Of all plants which contain saccharose, the largest quantity is found in the sugar cane, as may be seen from the following list:—

Sugar Cane *Saccharinum officinarum*	15 to 20 per cent.
Sugar Beet *Beta vulgaris* ..	8 ,, 18 ,,
Sorgo, *Sorghum saccharatum* ..	9 ,, 14 ,,
Pine Apple	11 ,,
Sugar Maple, *Acer Saccharinum*	5 ,,
Strawberry	5 ,, 6 ,,
Apricots	3 ,, 6 ,,

It is also found in small quantities in some varieties of birch, palms, and in maize stalks. Most other plants contain either grape sugar (dextrose), or fruit sugar (laevulose).

Cane sugar seems to have been first known to the Chinese, at any rate, they knew of the sweetening properties of the sugar cane, although it is doubtful whether they actually prepared crystallised sugar. At the time of Alexander the Great, sugar was brought into Greece, and the Grecian doctors employed it in medicine for curing all kinds of disease. The crystallised sugar appears to have been first prepared during the 7th century A.D., and was manufactured in Persia in the 8th century. The preparation of sugar and the cultivation of the cane followed in the steps of "the conquering Moors," during the 9th and 10th century, when it was introduced into Sicily and Spain. Fig. 1., taken from an old engraving, shows the manufacture of cane sugar in Sicily in the year 1570.

In the 15th and 16th century it was introduced by the Portuguese and Spaniards into Madeira, Brazil, and the Spanish West Indies. From this time on the cultivation of the sugar cane in the tropical countries, and the production of sugar, became a greater and greater industry. Many refineries of the raw sugar, obtained from abroad, were set up in Europe, and continued to flourish for many years, until, in 1806, Napoleon prevented the importation of the raw product. This practically killed the cane sugar industry on the Continent, but it resulted in the initiation of the beet sugar manufactory, which to-day is playing such havoc with the cane sugar industry. In this article the cane sugar industry will be first dealt with, as it is of greater antiquity, and also because the methods employed are simpler than those in operation in the beet sugar manufactory.

The chief cane sugar producing districts are Cuba, Java, Manilla, Mauritius. the West Indies, Northern India, North America, Brazil, Japan, China, Egypt, and the Sandwich Isles. In India it is being introduced with the hope that the cultivation of sugar, and its manufacture, may, to some extent, take the place of the waning indigo industry.

The sugar cane, as has already been shown, may, under favourable circumstances, contain from 18 to 20 per cent. of sugar, but when the agricultural and climatic conditions are not favourable, the amount of sugar may not be more than 15 per cent., as, for example, in Louisiana. The sugar cane belongs to the

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family *Gramineæ*. The outside of the cane consists of a hard, woody envelope, the interior consisting of a spongy mass of cells, between which the saccharine sap circulates. The leaves form at the very hard nodes, and each node is furnished with an eye. It is from these eyes that the plant is propagated. The cultivated plant does not bear seeds, so it, therefore, cannot be reproduced except by means of cuttings. The wild plant, however, reproduces itself by means of seed, but the wild cane contains very much less sugar than the cultivated variety. Fig. 2 shows the sugar cane, A, the incrustation of wax on the epidermis, highly magnified ; B, the floret.

When the cane has been harvested, the stubbles are left in the ground, and will again yield an abundant harvest, if the soil is kept in a good condition.

After the cane has been cut, it is taken to the mill, and should be crushed as soon as possible, because if left some time before crushing, the yield of sugar becomes less, and the quantity of glucose increases.

There are two methods for obtaining the sugar from the cane : 1, Crushing by means of heavy rollers ; 2, Diffusion.

Milling, or Crushing Process.—The cane, after stripping off any foliage, is passed through heavy mills, which consist of cast-iron rollers; it is then soaked in

Fig. 1.

The pieces of sugar cane, about a foot in length, which contain the bud, or eye, are planted in furrows about six to eight inches apart ; they are then covered with loose mould. After a period of from seven to twenty days, varying according to the variety of the cane, the age of cutting, and the weather conditions, the buds sprout, rootlets are sent into the soil, and the stalk and leaves begin to form. At the end of from 10 to 13 months, the cane has reached a height of seven to 15 feet, contains its maximum of sugar, and must be cut. If the cane is left too long, the quantity of sugar juice rapidly decreases.

For cane growing, the soil should be fertile and well tilled, but in a great many cases the growers neglect even the elementary principles of agriculture, keep their fields in poor cultivation, and without any manure whatsoever ; they then seem surprised that they obtain a poor yield of sugar.

water, and again passed through a rolling machine. Although the pressure exerted is very great, yet, owing to the cane being more or less elastic, and the centre portion being of a spongy nature, as it passes from the rollers it immediately absorbs a portion of the juice which has been expressed, hence the necessity of a second crushing. Fig. 3 shows diagrammatically a section of a mill.

It consists of three cast-iron rollers, A, B, C, which are rotated by means of gearing, the speed of revolution being two to three revolutions per minute. D is an inclined table upon which the canes are placed, they pass down between the rollers A and B, and then along the inclined guide E, between B and C, the expressed juice running into collecting gutters. The crushed material, or *bagasse*, is carried by means of a conveyer, through washing tanks, and from these tanks to another series of rollers, or sometimes between two sets

of rollers. The bagasse is dried and used as fuel, because in most places where sugar cane is manufactured fuel is expensive and difficult to obtain.

The juice, as it comes from the presses, is sometimes an opaque straw-yellow coloured fluid, but is often of a greyish-green. It usually contains a considerable quantity of suspended matter, which requires to be

(*A*—**Incrustation of wax on epidermis, magnified.** *B*—**Floret.**)
Fig. 2.

separated, such as fibres from the cane, albuminous matter, sand, and clay, etc. Owing, however, to its slimy nature, filtration is by no means easy.

In order, therefore, to clarify the juice, it is treated with lime. There are two processes of liming, defecation—in which only a small quantity of lime is employed— and carbonation, where an excess is added, and afterwards removed by passing in carbonic acid gas. The addition of the lime neutralises the free acids in the juice, thus preventing inversion, *i.e.*, conversion of the saccharose into glucose, when it is subsequently heated, and it also combines with the albumen. All these insoluble materials enclose the solid impurities already in the juice, and carry them down as they are precipitated.

Before adding lime, the juice is heated in steam-jacketed pans to about 80°. Milk of lime is now added in the requisite quantities, the mixture is then brought to the boil, when a scum which contains many of the impurities, rises to the surface, and is skimmed off. The middle layer of the juice is found to be quite clean, the upper layer is turbid, and the lower layer contains the main portion of the precipitated matter. The three layers are drawn off separately, the upper and lower ones being passed through filter presses.

The defecated juice is now ready for concentration. The old and wasteful method was to heat the juice in a series of pans over an open fire. This was wasteful, because of the large amount of fuel required, and because of the possibilities of burning the syrup.

The syrup to-day is, almost invariably, evaporated in vacuum pans; the syrup from the beet always. The amount of fuel used in France, with the old, open-fire method, for 1,000lbs. of beets, was 400lbs., to-day, less than 100lbs. of fuel is required. The most modern and satisfactory system of evaporation in vacuum is known as the multiple effect, it was invented by the Franco-American Rillieux. The system is shown in Fig. 4. It consists of three evaporating pans, C, C, C, the condenser D, and the pump P. Steam at about 7lbs. pressure is let into the heating tubes of the pan furthest away from the pump—the tubes are covered with the syrup to be evaporated. The steam causes the sugar solution to boil. Owing to the vigorous boiling, and no condensation, there is not very much vacuum in this pan, but the steam from the evaporation passes into the heating system of the next pan, where there is a greater vacuum, therefore, the juice boils at a lower temperature. The steam from this pan now passes into the heating system of the last pan, which is under a very considerable vacuum, consequently, the juice boils at a much lower temperature, and the steam from it is continually condensed by passing into a well cooled condenser. All the pans are connected together by cocks, so that the juice can be run from one pan to the other. During the evaporation this is done continuously.

When the juice is sufficiently concentrated, it is pumped out of the last pan. During the evaporation many substances held in solution by the clarified juice separate out, so that the juice becomes turbid again. It is very important to remove these impurities, because they become enclosed in the sugar crystals during the subsequent boiling process. The juice does not filter well, so is usually purified by boiling the syrup in eliminating pans, and treating with caustic soda or sulphurous or phosphoric acid, as may be found necessary.

The next process is the boiling, or final concentration of the syrup. This is usually done in single exaporating pans. The syrup is drawn into the pan, which is generally of iron, and contains coils for heating purposes. The boiler requires to be a man of great experience, because the yield and grain of the crystal-

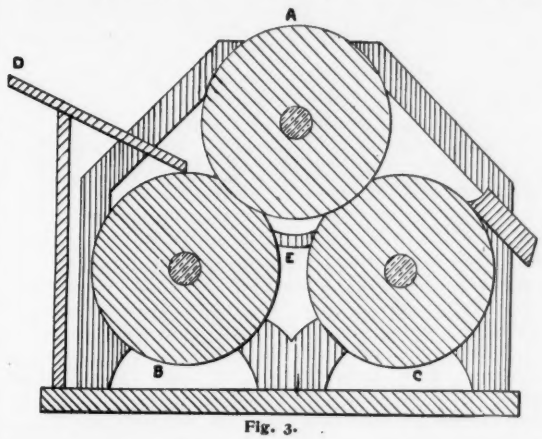


Fig. 3.

lised sugar depends entirely upon manipulation. It is not easy to explain shortly the manner in which this important process is carried out. For obtaining a sugar of average size grain, the procedure is essentially as follows: The syrup is drawn into the pan, which is under a vacuum of about 24 inches, the boiling point will then be about 60° (140° Fahr.). Steam is gradually

admitted into the coils as the syrup covers them. At the beginning boiling is very brisk, but as the concentration increases, it becomes slower. When the boiler considers the concentration sufficient, he lessens the supply of steam, and increases the vacuum, by this means the temperature of the contents of the pan fall to about 50°. The syrup is now supersaturated with sugar, and crystals commence to form. As soon as no more sugar separates, more steam is admitted, and a fresh quantity of syrup slowly drawn into the pan. When the pan is full, the supply of syrup is stopped, and the contents concentrated. The exact concentration, or striking point, has to be found by experience, and is determined by the firmness, a sample taken out of the pan by means of the proof-stick, acquires, when

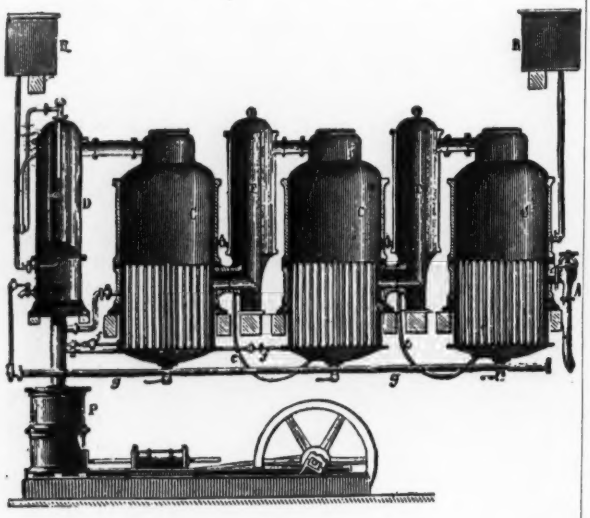


Fig. 4.

suddenly cooled in a pail of cold water. The mixture of crystallised sugar and molasses is now cooled, and then, after being stirred in a mixer for some hours to promote crystallisation, the porridge-like mass is centrifuged ; this process removes the molasses, and leaves the hard crystals behind. The sugar is finally dried in revolving iron cylinders fitted with steam coils. It is then packed, and is ready for the market.

Diffusion Process.—The principle of the diffusion method is based on the property possessed by certain bodies, when in solution, of passing through a membrane ; if on the other side of the membrane, a liquid is present, which contains a smaller quantity of the body in question in solution. This process of diffusion will go on until the concentration of the solution on both sides of the membrane is the same. Now, crystallisable substances, such as sugar, have this property, but gummy substances and albuminoid matter have not this power, or possess it to a very small extent. The process of diffusion is usually called dialysis. Now, in the living cell of the sugar cane, the protoplasmic tegument of the cell is not a dialytic membrane, but if the cell is killed, it then becomes a semi-permeable membrane, *i.e.*, is permeable to the one substance, but impervious to the other.

In the actual working of the diffusion process, the protoplasmic cell is killed by heat. The process is briefly as follows: The cane is cut up into small sections, which are placed into large vessels called diffusors, where hot water is poured upon them. The cells are killed, and then the sucrose, glucose, the acids, and certain inorganic substances diffuse through into the water. After a time, when a certain proportion of the sugar has diffused out, the sugary water is run off, and is replaced by a fresh quantity of water.

The first diffusion juice is poured on to a fresh quantity of slices, and this process of drawing off and pouring upon fresh slices is continued until the diffusion liquor finally becomes so far enriched that no further diffusion takes place. The juice so obtained is then concentrated and treated in the same manner as already described. The diffusion process is not used to any great extent in the cane sugar industry, although a very thorough exhaustion of the juice takes place.

A great advantage with the mills is that their capacity permits greater variations of output than is the case with the diffusion battery. For example, it is quite possible, in times of pressure, to crush as much as 600 tons per day with a milling plant only constructed to crush 450 tons. There are, however, advantages in diffusion, the extraction is more thorough, the juice is more easily worked, because most of the impurities remain in the *bagasse*, and finally there is less danger of breakdown than in the case of machinery. We will describe the diffusion process more exactly in its applications to the beet sugar industry, where it plays a most important rôle.

Exhausted Molasses.—A question of considerable importance to the sugar producer, is what to do with his molasses, which remain after the sugar has been separated, and from which a further quantity of sugar cannot be profitably extracted. A certain proportion of the better qualities can be used for treacle and golden syrup, but the manufacturer finds great difficulty in dealing with the major portion. If, in the neighbourhood, rum or arrach manufacture is carried on, then the most profitable outlet is to sell the molasses for the preparation of spirits.

The use of molasses as a fuel presents considerable difficulties. If it is burnt mixed with the cane refuse, at a comparatively low temperature, the charcoal chokes the grate, whereas at high temperatures the lime and other salts and the silica in the husks, form a kind of glass, which blocks up the bars of the grate, and prevents free access of air. In large factories special furnaces are sometimes built. The molasses are poured on an iron plate before the furnace, here they dry, and are then shovelled into the furnace. After the fire is once lighted, it goes on without more fuel, other than the dried molasses, and a fine ash, nearly free from carbon, is obtained. The ash is very valuable as a fertiliser, because it contains 35 per cent. of potash salts. It may also be used by glass-makers or soap boilers. In fact, it often pays to burn the molasses for the sake of its ash only.

It must be borne in mind that the process of manufacture here described is only concerned with producing Demarara or brown sugar. The further refining to obtain a fine, white, loaf sugar is a separate process altogether, and is not generally carried out in the neighbourhood of the sugar plantations. Large refineries are to be found, for example, in Liverpool and Greenock.

The manufacture of sugar from the beet root will be dealt with separately.

The diagrams, with the exception of Fig. 1, have been taken from "The Technology of Sugar," by J. G. Mackintosh ; Fig. 1 from "Geschichte des Zuckers," by Lippmann.

THE TOTAL ECLIPSE OF 1905.

A JOINT meeting of the Royal Society and the Royal Astronomical Society was held on October 19 to receive the reports on the observations of the recent eclipse from the several parties sent out under the auspices of these Societies.

The Astronomer-Royal gave a full account of the doings of the expedition to Sfax, and exhibited some fine photographs; Prof. N. L. Callendar narrated his experiences in Spain, when a thick cloud entirely impeded observations; Mr. J. Evershed and Mr. H. F. Newall also gave accounts of their observations, the latter showing a series of interesting photographs; and, finally, Prof. H. H. Turner told of what was done in Egypt. On the whole, these reports may seem a little disappointing, as nothing at all of a novel or specially interesting character seems to have been observed or recorded. Some faint oval patches or rings in the corona just above the large prominence were noticed by Sir W. Christie, who suggests they are the results of a large and sudden explosion.

It seems a great pity that some of these fine photographs should not be published for the benefit of the astronomically-inclined public, especially considering that the costs of obtaining them were, to a large extent, defrayed out of public funds.

The following accounts from observers in different places should prove of interest.

At Alcala de Chisvert.

By PROFESSOR MARCEL MOYE *(University of Montpellier)*.

I observed this magnificent eclipse at Alcala de Chisvert, a little town on the oriental coast of Spain. I venture to say I was favoured by the Spanish skies The day before we experienced dull and wet weather, and hope was almost gone ; but at night the clouds broke away, and stars were glittering everywhere. At sunrise, however, an ominous strip of clouds was hanging on the south, and all the morning we watched them on the horizon—a rather painful watch.

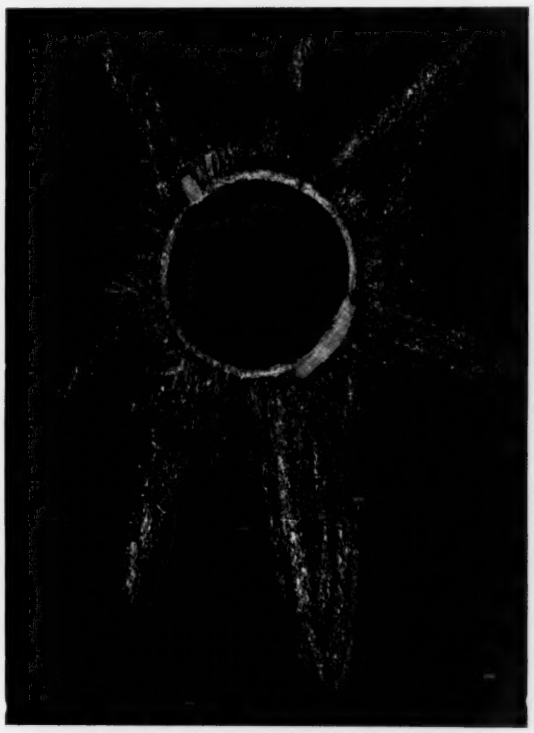
The first contact was seen in a perfectly pure sky, but, some minutes after, two or three cumuli went from the west, and slowly made their way before the sun. We were again almost in despair, but at the eventful moment the clouds were far north ; totality displayed its beauties without interference, except, at the end, for a light, transparent vapour of which I shall say a word later.

In order to secure good observations, I sketched for myself a very limited programme, and I had plenty of time to fill it without hurry. I intended to observe, 1st, shadow-bands ; 2nd, corona ; 3rd, general aspects of the eclipse.

Shadow-bands.—First as to shadow-bands. In the eclipse of 1900, at Elche, I had a good view of this phenomenon, and I was eager to see again these enigmatic bands. Here are my results.

I saw shadow-bands three minutes before and three minutes after totality, being unable to catch them during the total phase. They were greyish bands, not black, tolerably distinct and very wavy. Direction from south-west to north-east, and motion perpendicular, namely, from north-west to south-east, before and after totality. I must add that the wind—moderate—was blowing from south-west, and clouds went from west or west-north-west.

On the soil, white and smooth (the platform of the Alcala station), I had some rods with metric gradations. I estimated the width of the bands at two inches, and their distance apart at three or four inches. Their motion was slow, difficult to count exactly, perhaps one or two inches per second. You will obtain a good illustration of the shadow-bands by stretching a rope by one end and making it waving with your hand by the other end.



The Corona as seen at Alcala de Chisvert, by Professor M. Moye.

For the observation of the corona, I used a good opera glass. I sketched carefully the coronal streamers, and I had time enough to compare my drawing with the eclipsed sun. The sun was encircled in a splendid ring, very bright, almost dazzling, of a white, silver hue, fading away softly in the darkness of the sky. This inner corona was lengthened by an intricate system of streamers, seeming as a whole an irregular star with six or seven points. Two groups of prominences were

evident, even to the naked eye, with a magnificent rosy colour, the brightest at the north-east part of the lunar limb, the other at the south-west part, almost diametrically opposite.

All the coronal rays were more or less of an ogival outline, or "angel's wing," as noticed in previous eclipses. Their bases were broad, and they were tapering and melting away in an imperceptible mode. Three of the streamers are worthy of special notice.

The north-east ray was exactly hanging over the beautiful prominence seen at its root. It seemed as an extension or, better, a sequence to the solar eruption. I must add, however, that at the south-west part of the lunar limb the second group of prominence was apparently without influence on the coronal forms.

The north-west ray was very long, perhaps one and a half lunar diameters. Curiously enough, its north boundary was very sharp, even on the lunar limb, and the inner corona was as rifted by a dark line and very conspicuous.

As to the southern streamers, they went so far as two lunar diameters (from the limb), and marked with certainty the greatest coronal activity. The eastern one of these streamers seemed double, or formed by two ogives overhanging.

The general appearance of the eclipse was, on a whole, less interesting than in 1900. Brightness during totality was surprisingly intense. I read without any difficulty small letterpress, and sketched my drawing very easily. All features of the landscape were evident, and the illumination perhaps greater than in 1900—recorded as a bright one. With the exception of Venus, I was unable to see any star or planet. Sky was grey, not dark, rather a neutral tint, especially in the north, with a yellow band on the south. Clouds remained unchanged. On the landscape everything was greyish, without reddish hue, the general appearance being very sorrowful, and conveying some impression of ashes-rain. I think the illumination, decidedly brighter than that of a full moon night, was in relation with the great activity of the solar envelopes.

The eclipse wind was very noticeable, coming to a standstill some minutes after totality. The fall of temperature (in the shade) was only 5° Fahr., but in the height of atmosphere it must have been greater, for, at totality, a thin vaporous veil (alluded to before) made its appearance round the rim. It was not a cloud, not being visible before and after, and not moving, but rather a condensation of the aqueous vapour by the coolness of the shadow.

A last word. The corona of 1905 was brighter than in 1900, and especially active at the solar poles, a typical form of a maximum year.

At Campo de la Isla, Burgos.

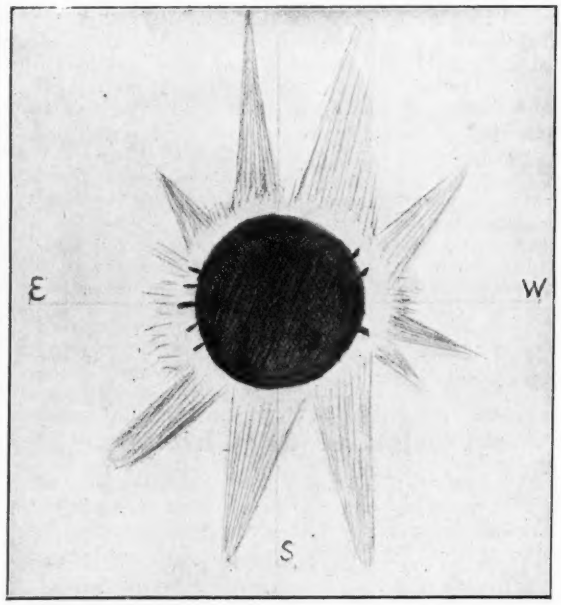
By C. NIELSEN, F.R.A.S.

Corona.—As per sketch herewith; inner ring very bright and about one-fifth lunar diameter in width; streamers faint and not extensive, longest about one and one quarter lunar diameters in length; colour pinky white. No vividness or sharp outline as at Ovar in 1900; became visible on West limb three or four seconds before totality.

Prominences.—Five large on East limb of usual bright cherry-red colour, except fourth from top which was somewhat paler (several persons reported to me that they had seen this and the chromosphere between 3rd and 5th prominences of a chemical green colour (? Coronium); possibility of complementary colour or colour-blindness eliminated by cross-examination); one of these prominences persisted an exceptionally long time before being covered up by the advancing moon; then two prominences in North-West quadrant followed two or three seconds later by an 8th in South-West quadrant, all of usual red colour, as was the chromosphere spendidly visible all round West limb.

Body of Moon appeared as disc—not as globe—of a dull grey-black colour.

Shadow not seen coming on, but very distinctly in drawing off over the distant 5,000 ft. high hills to East, taking a minute or more to reach horizon.



Copy of Sketch made immediately after Totality on 30th August, 1905.

Colours of earth and sky round horizon ashen-grey, then yellow to orange gold, round sun reddish-purple; darkness much more pronounced than at Ovar, but clouds spoiled these observations greatly; temperature also changed little owing to same cause; wind westerly, force 3, sky clouded, though totality from a few seconds before to about one minute after was seen in a clear patch of blue sky.

Bailey's Beads—seen by me so clearly at Ovar—though carefully looked for, were not seen, nor was Mercury visible at all; Venus shone brightly through cloud openings several minutes before totality, and Regulus ditto, but no other stars glimpsed, though looked for in their proper places, being all covered by light clouds; returning light brighter than vanishing, but cloudiness also detracted from this observation.

Shadowbands distinctly seen travelling from West to East at rate of five to six miles an hour, distance between bands estimated at 30 to 40 cms., and width of bands themselves 8 to 10 cms.

Effect on Animals.—No birds visible; donkey brayed, sheep bleated, and cavalry horse galloped wildly about when totality began.

XUM

At Vinaroz, Spain.

By FATHER AUGUSTIN MORFORD.

I had been staying for some days near Bordeaux. I started for Spain from the Gare du Midi on Sunday evening, August 27, at 6.42, and reached Vinaroz at 2.45 p.m. on Monday, after a much less difficult journey than I had expected.

Father Cortie was at the station of Vinaroz. He took me to the fonda (hotel), where I slept during my stay, and to the house of Doctor Sebastian Roca, where we took our meals in common. Our observation ground was in a field of lucerne adjoining Dr. Roca's garden. A gap had been made in the wall of separation for our convenience.

Father Cortie had three instruments for photographing the spectra in different manners, and a camera, for the corona, of about 20 feet focal length.

I, having brought the only telescope, a refractor of 4 5-16ths in., and intending to make only visual observations, was appointed to give order to open and close cameras at the beginning and before the close of totality. My own observations were made with an eyepiece x 70; field 52′, with two crossed spider threads dividing the field into quadrants.

Wednesday began auspiciously. The sun shone and the clouds were dissolved in the warm air, though overhead at a great height some were thickening.

First contact was observed at 11.54. It had already taken place a minute or two.

I watched several sunspots as they passed under the black disc of the moon. They did not differ sensibly in colour, observed with a prism and a green glass.

Now began our anxieties. A cone of cloud was rising slowly from the S.W. At twenty minutes before totality our chance of an untroubled view did not seem great.

As I had to announce totality I paid great attention to Baily's beads. This phenomenon differed considerably from that of 1900. As then, I noticed the abscission and subsequent disappearance of the terminal portion of the southern part of the crescent. Mr. Chambers has quoted in his Astronomy Halley's description of this in 1715. A second time there was a division, again at the south end, but less distinct. The crescent fined down very much. A little way from either end it became narrower than at the ends themselves. They appeared almost lance-headed, slightly diffused on the edges. The running together of the beads was much less pronounced than in 1900. There were *two* remaining at a slight distance from each other—that to the south disappeared first.

I had been observing too closely during the last few minutes to pay attention to the clouds, and I had seen Baily's beads so distinctly that I never thought there could be any. But I slipped off the green glass, and it was evident something was wrong. The black disc of the moon stood out forward. Behind there was a bright but diffused light, which seemed to come from behind the moon. But no coronal detail could be seen, nor in the telescope did I see any the whole time. However, I had no time to lose. The chief thing I intended to do was to map down the positions of the prominences, red, white, or pale tint, with coloured chalks. Five splendid prominences were glowing brilliantly in the N.E. quadrant. I had grey writing paper with circles in pencil, divided into quadrants corresponding with the wires in the eyepiece. I got the positions of the prominences approximately correct, but it was difficult at first to say of what colour they were. At first they seemed white, then I noticed a faint tinge of red, as of vermilion much diluted with Chinese white. When the chromosphere appeared it could not be said to be red. The atmospheric condition evidently was answerable for this, and what I saw were the usual hydrogen prominences. None were in the least like the two shining white columns I saw at Ovar in 1900. All were somewhat plumy, or cloudlike, or arboreal in form. One of the latter shape had a double trunk.

Long before these prominences in the N.E. were covered by the moon's disc, one appeared *floating* with no attachment, not more than 30°, if so much, from the North Pole, in the N.W. quadrant. Others gradually revealed themselves, till I had mapped seven; in both quadrants 12. I saw none in the southern hemisphere. All were pale, but very brilliant. Those in the N.W. quadrant had, perhaps, a trifle more colour.

I found it useless to observe the corona with the telescope, so I had several good looks with the naked eye. Though there was a small thin cloud covering the sun, the corona was most brilliantly visible through it. It was not pearly or silvery white, nor was there any trace of colour. The moon was the blackest of blacks, and the corona the intensest of whites, and very bright. The full moon at the meridian was not comparable with it in tint or brilliancy. I thought of our Lord's garments at the Transfiguration, "candida nimis velut nix."

The diameter seemed about half a solar diameter broad. It was, of course, impossible to see any faint outlying parts. It appeared pretty equal in breadth all round, the edge bordered with aigrettes. For the last 10 seconds it was free from clouds, but I saw nothing to add to, or take from, what I have recorded.

I had to give the order to close cameras, so I watched carefully for the orange-red glow of the chromosphere. I saw no decided colour, but the western limb suddenly became so bright that in some alarm I called out "Close!" and in one second the sunlight appeared. Totality had lasted 3 mins. 25 secs., as against 3 mins. 36 secs. calculated.

The sunlight gained with extraordinary rapidity, by bounds, as it were, so that almost at once all impression of eclipse was gone. Before long one felt the sun beginning to scorch again in cloudless intervals. The temperature had been agreeably cool for some time before totality.

The darkness may be estimated by the following:—The grey notepaper on which I drew had a fairly dark circle in pencil, and cross lines about twice as broad and dark. The latter were clearly visible, but the former so little so that I found my red chalk marks were some within and some without the circle.

I heard from others that they had seen the undulating shadows. None of us had time to look for them.

There were no flowers and very few birds to observe. The behaviour of the latter was distinctly abnormal, as they were terrified by the discharge of bombs by a well-meaning person who hoped thus to break or scatter the clouds. This is commonly done (or attempted) in the case of thunder clouds, which are low. But as these bombs are loaded to burst at from 400 to 500 metres, and the clouds were enormously higher, their effect, as might have been foreseen, was *nil*.

The houses, mostly flat topped, were crowded with spectators, who applauded the eclipse so heartily that my signals and Father Cortie's counting of seconds were not too easily heard. As a spectacle, at least, the eclipse was highly appreciated by them.

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Eclipse Shadow Bands.

During the recent total solar eclipse of August 30 there appear to have been numerous satisfactory observations of the shadow bands, and from the very definite nature of many of the reports now coming to hand, it appears very hopeful that some advance towards the determination of their causation may result. The following notes summarise some of the data supplied:—

Constantine (*Algeria*).—M.M. Henri de la Vaulx and J. Jaubert, observing at a station about 660 metres above sea level, state that the bands were visible 20 seconds before and after totality; although subject to various irregular movements, it was found that on the horizontal plane their length was in the general direction—N.E.-S.W. During the shorter intervals of 7 seconds before and after totality a second series of shadows were noticed intersecting the first series, always at an angle of about 25°. These had a width of 6 cm. or 7 cm., with intervening clear spaces of 60 cm. or 70 cm. The direction of motion of the bands was regular and definitely determined to be west-south before the eclipse, and in the opposite direction after.

Tripoli (*Barbary*).—M. Lucien Libert observed the bands on a sheet of 25 square metres. They were first seen 6 minutes before totality, and had the appearance of alternate bands of light and shadow, displacing themselves in a direction perpendicular to their length. They were not absolutely sharp, and at intervals appeared serpentine, as if affected by the wind. The following summary is given of the directions of the bands and their movements:—

Time.	—	Direction of Bands.	Directions of Motion.	Direction of Wind.
h. m. s.				
2 39	First series of Bands	N 60° E or S 60° W	S 30° E	S 35° E
2 41 15	Second ,, ,,	N 80° E or S 80° W	S 10° E	S 43° W
2 51	Third ,, ,,	N 45° E or S 45° W	S 45° E	S 60° W

REVIEWS OF BOOKS.

Junior Course of Practical Zoology, by the late H. M. Marshall and C. H. Hurst; 6th edition, revised by F. W. Gamble (London: Smith, Elder, and Co., 1905; pp. xxxiv. + 490, illustrated; price 10s. 6d.).—The mere fact of a text-book having reached its sixth edition affords such all-sufficient and convincing evidence of its popularity and its fitness for its purpose that any commendation on the part of a reviewer is a mere work of supererogation. Nevertheless we cannot pass over the edition which Dr. Gamble has in so many ways made superior to its predecessors without adding one word of approval to this excellent and invaluable little laboratory manual. In every way it is admirably suited to the needs of the student; a feature in which it excels so many of its rivals being the specially distinctive type, of various grades, in which the different parts of the structure of each object described are printed. By this arrangement the student is enabled to find exactly what he wants at the moment without any vexatious delay; and although the arrangement of such details may seem a trivial matter, yet it is one of which only experienced teachers, like the lamented authors of the present work, are able to recognise the full importance and value. Another distinctive feature of the volume before us is the comparatively limited number of the illustrations; and although this may at first sight seem a disadvantage, it is in reality a great merit, since it compels the student to resort to actual dissection, and prevents him from trying to obtain his knowledge at second hand by merely studying figures of the labours of others. The only adverse comment we have to make in connection with a work in every respect admirable, is that we regret the editor did not see his way to conform to modern usage by substituting the name *Branchiostoma* for *Amphioxus*.

Extinct Animals, by E. Ray Lankester (London: A. Constable and Co., Ltd., 1905; pp. xxiii. + 331, illustrated; price 7s. 6d. net).—"A book that tells you exactly what you want to know about animals" was the comment made by a member of the present writer's family after perusing a copy of this profusely illustrated volume; and as this tribute came spontaneously from one of the "young people" to whom the author specially appeals, it may be taken as satisfactory evidence that he has hit the mark at which he aimed. Professor Lankester is indeed justly famed for his power of imparting information on abstruse subjects in a manner which, while thoroughly accurate and often detailed, yet arouses the interest of his hearers or readers to such a degree that, in place of being wearied, they are left with an overwhelming desire to know more about the subject under discussion. And as an example of this excellent—and indeed only true—way of teaching, the volume before us, which is a revised report of a series of lectures delivered by the author before a juvenile audience at the Royal Institution during the Christmas holidays of 1903-4, can hardly be excelled. Whether discoursing on the evolution of the elephant and the marvellous way in which the jaws of its ancestors were first lengthened to form a kind of "bogus" trunk, and subsequently shortened when the real article was developed, or discussing the strange fossil reptiles of South Africa and Russia and their relation to mammals, the author is equally successful in maintaining the interest of his subject and carrying his readers with him. Big animals apparently have a special fascination for the learned professor, and the reader is introduced in turn to the thigh-bone of the mightiest reptile that ever trod this earth, to the fossil tooth of a shark beside which the dental weapons of modern species are mere playthings, and to the longest and heaviest elephant's tusk ever put on the London market. Of course, a few holes may be picked here and there by the captious critic; and we doubt not that in a second edition the author will remove *Dimetrodon* from the Theromorpha (p. 212), while he will compare the tail of an ichthyosaur with that of a shark instead of that of "a fish" (p. 227), and will alter a certain sentence (p. 94), which, to our mind at any rate, conveys the idea that rhinoceroses possess trunks. Such little incidents detract, however, in no wise from the value and interest of a work which only a man of unusually comprehensive mind and great powers of generalisation could possibly have written, and which will certainly appeal to a much wider circle than the young people for whom it is claimed to have been specially written.

A Popular Introduction to Astronomy, by the Rev. A. C. Henderson, B.D. (T. & J. Manson, Lerwick; 2s. 6d. net).—This little book is exactly what its title implies. It is clearly and popularly worded, and tells just what those who have not made any study of the subject would mostly want to know. And there is no waste of words; almost every sentence contains a fact worth recording, and the facts are reliable. The book is quite up to date, mentioning Jupiter's 6th and 7th satellites. We can thoroughly recommend this concise little guide to all who wish to gain a grasp of the great science of Astronomy in an hour or two.

A Technological and Scientific Dictionary. Edited by G. F. Goodchild and C. F. Tweney (G. Newnes). Part X. (Pyr-San). 1s. each part.—A good explanatory collection of terms used in science is much needed, and this work, which is gradually being brought out in parts (and will be completed with the 13th), should supply the want. The definitions here given are mostly full and correct, and in some instances, such as under the headings of "Pyrrole," "Radio-activity," "Railways," "Rubber," and "Sanitation," articles of several columns are given. But it seems a pity that the line is drawn where it is as regards the classification of subjects to be included. Thus, though such subjects as music, painting, and even heraldry are fully treated of, military and naval sciences are not referred to (Range-finders, Rifles, Redoubts, Rockets, Sails and Sailing, &c.). We find the dress of the ancient Roman soldier and mediæval armour described (Sagum, Salade, &c.), but not the equipment or armament of the warrior of to-day; rapiers are defined, but not rifles. Various other subjects, too, which might well be included in the term "Technological and Scientific" are not gone into. Several words, such as *Rarefaction* (of air), *Repulsion* (motor), and *Réaumur* (thermometer scale), are conspicuous by their absence. We must hope that a full appendix will be added to include these omissions.

NOTES.

ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C Sc. (Lond.), F.R.P.S.

Variation of the Figure of the Sun.

IN the early seventies Lewis M. Rutherfurd obtained a considerable number of excellent photographs of the sun at his private observatory, and these were later presented by him to the Observatory of Columbia University, New York. As it has been shown that stellar photographs taken by the same astronomer are capable of giving results comparable with the best heliometer determinations, Prof. C. L. Poor, of this Observatory, has lately been induced to examine the old solar photographs with the object of finding any evidence of changes in the form of the solar disc.

In all there are 139 photographs, extending over the period 1860-1874, but part of these were only with a small lens. Those taken from 1868-1874 were with his 13-inch telescope, and of these plates 22 have been selected as suitable for minute measurement, and on each the polar co-ordinates of twenty-eight points round the limb have been determined. Dividing these into two sets and taking means, it was possible to obtain a most probable value for the polar radius, and for the equatorial radius, of the solar disc on each plate. The differences of these radii are tabulated in order of time, and it is shown that there is a consistent agreement for the plates of any one year, but that the plates of different years differ radically. Thus the plates in 1871 show the equatorial radius to exceed the polar by some 0″·3, while the plates of 1870 and 1872, on the other hand, show the polar radius to be the greater by about 0″·2. A critical examination of the records shows that the instrumental conditions, time of exposure, orientation, &c., were as nearly as possible constant, and it must therefore be due to a real expansion and contraction of the sun's disc.

An interesting confirmation of these conclusions was then furnished by a discussion of the heliometric measures of the sun's diameter which were made by the German observers in preparation for the transits of Venus in 1874 and 1882. Professor Poor has arranged all these solely with respect to time of observation, and finds they readily fall into two series, one from September, 1873-January, 1875, the other from May, 1880-June, 1883. In both of these groups it was found that there was a progressive change, and that of the first group was in the same direction as that indicated by the Rutherfurd plates, while the second group was opposite. Thus during the interval from 1881-1883 the equatorial diameter was apparently growing longer in relation to the polar diameter, while during the former period, 1874-1875, the equatorial diameter was growing relatively shorter.

Again, photographs of the sun taken at Northfield, Minnesota, by H. C. Wilson, during 1893-1894, indicate a shrinking of the equatorial diameter with respect to the polar diameter.

On examining the epochs of these changes, it is at once apparent that they have a distinct relationship to the curve of sun-spot frequency, and on plotting the values there is good agreement as far as the observations go.

These investigations seem to show, therefore, that the ratio between the polar and equatorial radii of the sun is variable, and that the period of this variability is the same as the sun-spot period. The sun appears to be a vibrating body whose equatorial diameter, on the average, exceeds the polar diameter. At times, however, the polar diameter becomes equal to and even greater than the equatorial—the sun thus passing from an oblate to a prolate spheroid. It is possible that in this variable figure of the sun may lie the explanation of the anomalies in the motions of the planets Mercury, Venus, and Mars.

Polarisation Observations during the Solar Eclipse, August 30th, 1905.

A very interesting series of polariscopic determinations are reported by M. Salet, who was appointed by the Paris Bureau des Longitudes to observe the recent total solar eclipse at Robertville in Algeria.

His first effort was the endeavour to detect any existence of a magnetic field in the neighbourhood of the sun by observing if the plane of polarisation of the coronal light suffered any deviation. This plane should, from reasons of symmetry, be radial if no magnetic field existed in the gaseous atmosphere. For these observations an equatorial telescope of 95 mm. aperture was employed, furnished with cross wires and a Savart polariscope placed before the eyepiece. This can be turned, before the observation, so as to suppress the bands due to terrestrial polarisation. During totality the bands were well seen on the corona. The plane was found to be deviated in the right hand direction by 2° S. The smallness of this indicates that the sun has, in spite of its mass, only a slightly magnetic field.

With another apparatus M. Salet was able to obtain good photographs also of the coronal polarisation, showing fifteen bands on the width of the solar diameter. They are visible for about a diameter and a half from the solar limb, practically up to the edge of the external corona. The polarisation had a maximum intensity about 5′ or 6′ from the sun's limb, the plane of polarisation being almost radial, and the slight deviation measured visually was thus verified. A prominence found crossing two bands apparently suffered no change of intensity, showing without doubt the non-polarisation of the prominence light. On none of the plates is there any trace of atmospheric polarisation outside the corona or on the moon.

For comparison, several observations were made of atmospheric polarisation by means of two Savart's directed 90° from the sun, but at this distance no bands were visible during totality. At 30° or 40° from the sun, however, the bands were easily seen during totality. In the neighbourhood of the sun the plane of polarisation was vertical.

A spectroscope was also provided with half its slit covered by a nicol. The spectra obtained show different intensities on the two halves by reason that on one the reflected solar light is suppressed by the nicol. The coronal radiation, strong up to 4′ from the limb, is shown on both sides. Rays of hydrogen and calcium are also shown, and others which will be measured later.

CHEMICAL.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

The Chestnut Flour of Corsica.

THE chestnut is the wheat of Corsica, and its flour is used in the form of bread or polenta by the peasants throughout the island. The chestnuts are slowly dried over a small wood fire and stored until required for grinding. The mills are of the simplest construction and consist of a wooden water wheel whose axis turns a millstone which crushes the shelled chestnuts against a fixed stone. The cheaper grades of flour are of a dirty colour owing to the presence of particles of the shells, and contain between 11 and 12 per cent. of moisture. The composition of different varieties of the flour has been determined recently by M. Comte, who finds that chestnut flour closely approximates wheat flour in its food value. It contains about the same amount of starch, more fat and cellulose, but less nitrogenous substances (7 to 9 per cent., as against 12 to 16 per cent. in wheat flour). Chestnut flour attracts moisture very rapidly, and therefore soon becomes mouldy unless kept in air-tight vessels. It has also the drawback of being very refractory to the action of yeast, and thus producing an inferior kind of bread.

The Formation of Ozone by Ultra-Violet Light.

It has been shown that the ultra-violet light emitted by an electric mercury lamp produces violet colorations in glass containing manganese which are otherwise only produced very gradually by sunlight under normal conditions (" KNOWLEDGE AND SCIENTIFIC NEWS," this Vol., p. 158). The ultra-

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violet rays from the lamp have also a marked effect upon oxygen according to the results of further experiments made by Drs. Fischer and Braehmer. When pure oxygen is conducted through the lamp with precautions to keep the temperature low, a considerable proportion of ozone is formed, the yield increasing with the strength of the light up to a certain point and then diminishing. If the temperature is too high no ozone is produced, since that first formed is reconverted into oxygen. It is pointed out that these experiments support Warburg's view that the formation of ozone noticeable in silent electric discharges is due to the emission of ultra-violet light.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

The Age of the Earth.

PROFESSOR SOLLAS is always interesting, whether he is reading a paper, and laying himself open to the criticism of others, or whether he is criticising with sledge-hammer blows a paper given by one of his geological colleagues. But he takes criticism in good part, and it is well that he does, for he has given every opportunity for it in his "Age of the Earth" (Fisher Unwin). He does not exactly say how long the stratified deposits of the earth have taken in forming, but leaving aside the possibility of radium and other radio-active bodies acting in such a way as to upset all preconceived ideas on the subject, he gives us the total of twenty-six millions of years as the time which would have been necessary to deposit all our sedimentary formations, at the assumed average rate of accumulation of one foot in a century. In asking, how far does this period satisfy the demands of biology, although he is aware that eminent biologists are not wanting who share his opinion, he answers for himself, Amply. He might also have added that there are many who cannot share the opinion.

Thickness of the Earth's Sedimentary Formations.

Incidentally, it is interesting to note the sum total of the maximum thicknesses of the sedimentary deposits, so far as Professor Sollas has been able to discover them. He gives a total of 265,000 feet, or about fifty miles, at the base of which are the great American pre-Cambrian formations, Huronian, 18,000 feet; Penokee, 14,000 feet; Keweenawan, 50,000 feet; although there seems to be some doubt as to the thickness of the last-mentioned. It will be necessary for our text-book writers in future to have a care not to repeat the oft-quoted thickness of about a dozen miles of sedimentary rocks.

The Sun as a Non-Luminous Star.

Sollas quotes Kelvin's argument that the life of the sun as a luminous star is even more briefly limited than that of our oceans. This means that if the age of the sedimentary rocks is as already given, our oceans may have been formed fifty-five millions of years ago, and that after a short existence almost as boiling water, they grew colder and colder, till they became covered with thick ice. So the earth may have remained, frozen and dark, until in obedience to the growing splendour of the sun, the long night of the earth became banished, and the commencement of running waters was the beginning of the formation of the sedimentary rocks. Just one suggestion here. Is it altogether inconceivable that life may have existed in the heated waters of the earth in the days of the non-luminous sun?

The Radium "Apparition."

Professor Sollas speaks picturesquely of a new cause of disturbance, which looms up before us, "vague and gigantic, threatening to destroy all faith in hitherto ascertained results, and to shatter the fabric of reasoning raised upon them." This apparition is radium. If the earth possesses radium throughout its mass to the extent of one five-millionth of a gram per cubic metre, it has been asserted that the whole of the heat lost by radiation into outer space would be compensated for, and the temperature gradient would be unchanged for a very long period. So the geologist breathes freely again, and blesses the apparition.

Fossil Trees in Victoria Park, Glasgow.

Glasgow is fortunate in possessing, in its Victoria Park, the remains of an old carboniferous land-surface, which when laid bare showed a number of petrified broken trunks and roots of

Fossil Tree Trunk (Sigillaria), Glasgow.

Sigillaria. These have wisely been protected, and by the erection of a commodious shed over them, have been preserved from the effects of the weather. We reproduce some photographs of them. We know of no object-lesson so likely to

Fossil Tree Trunk (Sigillaria), Glasgow.

arouse interest in the study of geology as that presented by these easily-accessible specimens of a by-gone age. We plead for a better use of such specimens, and for a more general adoption of the study of geology in our Polytechnics.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

Bee-eaters in Yorkshire.

THE *Zoologist* for October reports the occurrence of three Bee-eaters at Bentham, Yorkshire, during the middle of September. They had halted by the way in a garden, where they discovered a promising supply of food in the occupants of a number of bee-hives. On one of the number, an adult male, being shot, however, the rest appear to have moved off to safer quarters.

Hoopoe in Sussex.

Mr. J. S. Snelgrove writes to the *Field*, October 7, to say that he saw a Hoopoe on September 26 at Rotherfield, Sussex. The bird was sitting in a cart rut, but rose quickly and flew out of sight behind some trees. Doubtless we shall soon hear that it has been shot.

Common Quail in Ireland.

Mr. Allan Ellison gives a short account in the *Zoologist* for October of the re-appearance in some numbers of the Common Quail (*Coturnix communis*) in Enniscorthy, Co. Wexford, during July last. This note is of interest, inasmuch as for the past few years this bird has been rather scarce in Ireland.

Solitary Snipe.

Mr. A. R. Brooke writes to the *Field*, October 14, to record the fact that a Solitary Snipe was shot on October 6 in Pembrokeshire, but no particulars as to sex or weight are given.

An adult Great Snipe weighing 6 ozs. was shot at Snettisham during the last week in September. The average weight for this bird, we might remark, is about $7\frac{1}{2}$ ozs.

We learn from the *Field*, September 30, that a Solitary Snipe was shot "lately" in the middle of Ackergill Moor, near Wick. The age, weight, and sex of this specimen are not stated.

Greenland Falcons in Ireland.

The *Irish Naturalist* for October contains a note by Mr. H. J. Moran on the shooting of no less than eight examples of he Greenland Falcon on the West Coast of Ireland during this summer. Near Belmullet two females and an immature male were shot, while three others were seen of which one was trapped but escaped. At the Great Skellig an adult male and an adult and immature female were shot; at Crossmoline, Co. Mayo, another, sex not stated, was shot, while a young female was killed in Co. Cork. Expressions of regret for this slaughter are in vain.

Iceland Falcon in Co. Galway.

An immature female of this species was exhibited at the Dublin Naturalists' Field Club in March last, which was shot in Oughterard, Co. Galway.

Honey Buzzard in Norfolk.

The *Field*, October 7, records the fact that a Honey Buzzard was shot at Snettisham, in Norfolk, "recently." The bird was an immature specimen, and was killed in the act of rifling a wasp's nest.

Manx-Shearwater.

Mr. A. H. Patterson records in the *Zoologist* for October the finding of a Manx-Shearwater on the beach at Great Yarmouth, which appeared to have been dead some four days.

In the same journal is a record of the Manx-Shearwater in Worcestershire, one having been shot on a small piece of water near Bromsgrove on September 16.

PHYSICAL.

By ALFRED W. PORTER, B.Sc.

Regularities in Spectra.

A NOTABLE advance has been made by Dr. Halm (Lecturer in Astronomy in the University of Edinburgh) in connection with the structure of spectra. Hitherto special formulæ have been needed in special cases to represent the series of lines which occur in spectra. Thus, for the lines on a "band" spectrum, Deslandres has used the formula $n = n_0 \mp am^2$ where n_0 is the frequency of the first line (the *head* of the band) and m is any integer; while, for line spectra, Kayser uses either the formula $n = a + bm^{-2} + cm^{-4}$ or similar expansions, and Rydberg the approximate formula $n = a + \frac{b}{(m+c)^2}$, where a, b, and c are constants and m is any integer. The different type of equation necessary for line or band spectra respectively seemed to indicate that these kinds of spectra were fundamentally different from one another. Dr. Halm has now shown that a single type of equation is sufficient for representing *all* spectra, and that it represents them much better than those previously used. This equation is

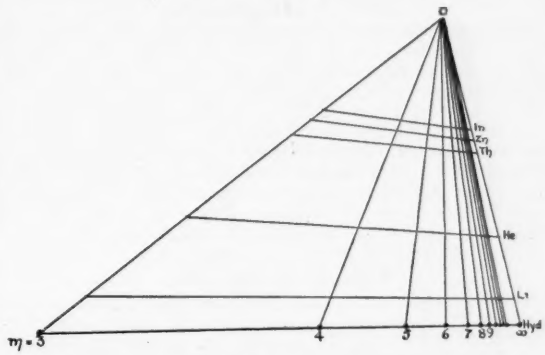
$$\frac{1}{N-n} = a(m+c)^2 + b$$

where N, a, b, and c are constants and (as before) m is any integer. When b is zero this equation is identical with Rydberg's; on the other hand when c is zero and b is very large compared with a, it approximates to Deslandres'. Curiously enough a formula, of which this is merely a mathematical modification, had already been employed by Thiele for band spectra; but he rejected it as inadequate. Halm shows that this rejection was unwarrantable and resulted simply from Thiele wishing the formula to do more than was necessary. In Dr. Halm's paper most known series are carefully worked out and adequately represented. For many cases the constant c is zero (it is so for 19 series out of 44). All the first subsidiary series (except Mg, Ca, Sr) belong to this group. In other cases c is usually a simple fraction, such as $\frac{2}{15}$. The occurrence of these groups shows that remarkable relations must exist between series of lines belonging to different elements, but of the same group. For example let n_x be the frequency of the xth line of a series, and n_x^1 that of the same line in any other series *belonging to the same group*; then if n and n^1 are any other corresponding lines in the same two series and e is a constant

$$\frac{1}{n_x - n} - \frac{e}{n_x^1 - n^1} = \text{constant}.$$

Hence if n_x, n_x^1 and the constants be known the whole of the second series can be calculated from the first. In this way Dr. Halm calculates eleven lines in the third subordinate series of Helium from the well-known Hydrogen series, for both of which c is zero. An interesting geometrical relation can also be exhibited. If we mark upon a straight line, on any arbitrary scale, the lines of a given series in such a way that the distances between two lines express the differences of the corresponding frequencies, and if from any point outside we draw straight paths through the points so selected, then the lines of any other series belonging to the same c-group can be represented as the points of intersection of those straight paths with a certain transversal line.

The following diagram will illustrate this theorem:—



On the base line the dots show the relative positions of the hydrogen lines corresponding to m = 3, 4, 5 . . . ∞. From an arbitrary point O lines are drawn to these dots. The remaining lines have then been placed so that their points of intersection with the radial lines give correctly, on the same scale, the frequencies of the lines in one series for each of the following substances:—Lithium, Helium, Thallium, Zinc, and Indium. All spectra of the same group thus drawn would appear to coalesce if viewed from the point O.

In order to show that the formula is as valid for band as for line spectra, Dr. Halm calculates the wave lengths of the first triplet series in the *line* spectrum of Oxygen from the wave lengths of lines in the Cyanogen *band* spectrum!! The question of the regularities in spectra is obviously placed on a fresh footing.

Dr. Halm's paper appeared in the *Roy. Soc. Edinb. Transactions*, July, 1905.

[Since writing the above abstract I have discovered that this formula has previously been discussed by Professor Fowler, of the Royal College of Science, in *The Astrophysical Journal* for 1903. He shows there that it is the most satisfactory formula for line-spectra. He also applied it in *The Astrophysical Journal* for January, 1905, to the new triplets in the arc-spectrum of strontium which were discovered by him. He therefore has the credit of having anticipated Dr. Halm so far as line-spectra are concerned. He does not appear, however, to have applied it to band-spectra.]

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ZOOLOGICAL.

By R. LYDEKKER.

The Connecticut Footprints.

DR. R. S. LULL, of the Agricultural College at Amherst, in Massachusetts, has recently been devoting attention to the wonderful tracks of fossil animals in the sandstone strata of the Triassic strata of the Connecticut Valley, which have been known to the inhabitants for well nigh a century, and were described many years ago by the late Professor Hitchcock, President of Amherst College, who believed most of them to have been made by birds. Owing to the porous nature of the sandstone, very few of the bones of the ancient creatures which formed these tracks have hitherto been discovered, and for a long time indeed, none were known. The few skeletons that have been found indicate, however, that these tracks, as was to be expected, were made by dinosaurian and kindred reptiles, some of which walked on their hind legs alone, while others went on all four. One of these bipeds was a large carnivorous species, which left three-toed tracks of one type. Another dinosaur, of herbivorous habits, has also left footprints which are in most cases not very dissimilar to those of its carnivorous relative; but in places we find indications that the creature sat down, resting its tail and small five-toed front feet on the ground; thus proving that some at least of the four-footed tracks were made by animals which were normally biped. One type of four-footed tracks has, however, been proved to have been made by a reptile very similar to a crocodile in structure, but with the body carried high above the ground on long stilted mammal-like limbs. For this creature the name of *Stegomus longipes* has been proposed, but it ought surely to bear the title *Batrachopus grucilis*, bestowed long previously on its tracks.

British Dinosaurs.

In the July number of the *Geological Magazine* Baron Francis Nopcsa continues his restorations of British dinosaurian reptiles, dealing in this instance with the remains of a large carnivorous species from the Oxford Clay preserved in a private collection at Oxford itself. By most palæontologists these remains would be referred to the well-known genus *Megalosaurus*. Baron Nopcsa identifies them, however, with a reptile represented by a few bones in the Paris Museum, described under the name of *Streptospondylus cuvieri*, and states that this creature is distinguished from *Megalosaurus* by having four, in place of only three, toes to the hind feet. We await with interest the comments of Baron Nopcsa's fellow-workers.

Black Leopards.

Black leopards, like black jaguars and black pumas, are not a species of themselves, but merely a dark phase of the ordinary spotted leopard. It is, however, interesting to learn from India that the former animals, so far as the evidence from a single instance goes, when mated with individuals of their own kind breed true, although when crossed with the spotted race the offspring may be of either type. In the instance referred to two litters of wholly black cubs were produced by a pair of these dark leopards.

A Curious Squirrel.

A remarkably coloured new species of squirrel has recently been described from Upper Burma, under the name of *Sciurus haringtoni*. Unlike any other known member of the group, this species is of a pale creamy buff colour above, with the tail whitish and the under-parts buffish. As two specimens were obtained, it is unlikely that we have to do with an albino form; and an adequate explanation for this departure from the normal type of squirrel coloration is therefore required.

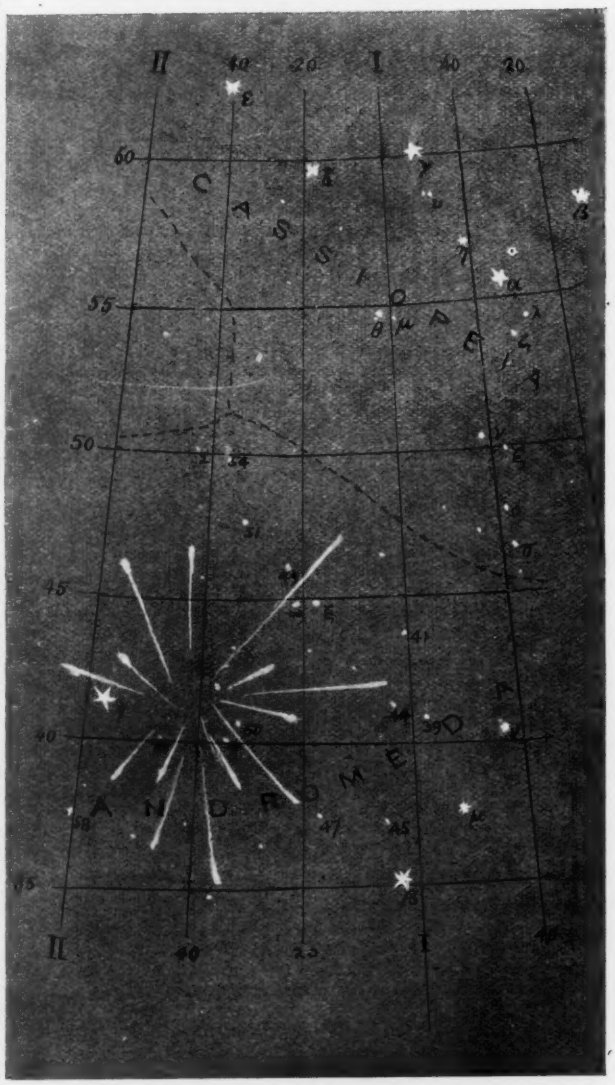
The Indian Palm-Squirrel.

Everyone who has visited India is familiar with the pretty little striped palm-squirrel, which is to a considerable extent a partially domesticated animal, or, rather, an animal which has taken to quarter itself in the immediate neighbourhood of human habitations. Hitherto it has been generally supposed that there is only one palm-squirrel throughout India. It has been recently shown, however, that there are really two distinct types, each with local modifications. The first or typical palm-squirrel, *Sciurus (Funambulus) palmarum*, inhabits Madras, has but three light stripes on the back, and shows a rufous band on the under-side of the base of the tail. In Pennant's palm-squirrel, *S. (F.) pennanti*, on the other hand, there is a pair of joint additional lateral white stripes, making five in all, and the under surface of the tail is uniformly whitish olive. As this species has been obtained in Surat and the Punjab it is believed to be the northern type.

New African Antelopes.

A well-known German naturalist has recently described no less than twelve antelopes from East Africa as new; many being ranked as species and a few as sub-species, although we should be disposed to relegate the majority to the latter grade. Perhaps the most interesting feature in the communication in question is the naming of a new genus (*Rhynchotragus*) for those curious representatives of the tiny little antelopes commonly known as dik-diks in which the muzzle is produced into a kind of miniature trunk; *Madoqua guentheri* being the typical representative of this sub-group.

November Meteors.



The above is a Map of Region of the Andromedid Showers of Meteors which may be expected about 17-23 Nov., showing the radiant point. This Region is near the Zenith about 9 to 10 o'clock on those dates.

Photography.

Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

Pinatype.—This is the latest method of three-colour photography, the instructions and materials for which are issued by the colour works, formerly Meister, Lucius, and Brüning. Messrs. Fuerst Bros., of Philpot Lane, are the English agents. The method is, I believe, intended for the use of amateurs and those who make their own prints rather than for commercial work. The ordinary three negatives are made through a blue, green, and red colour-screen respectively. From each of these a transparency is made either by superposition or by common enlarging methods, and each transparency in turn furnishes a "print plate" by exposing beneath it a plate coated with gelatine and rendered sensitive by means of potassium bichromate. After due exposure the "print-plates" are washed, and, with or without drying, each is placed in a solution of the appropriate dye. The colouring matter is not absorbed where the gelatine has been completely hardened by the exposure, but it is taken up in the other parts, most copiously where there has been least exposure under the positive. The final print is prepared by squeegeeing a piece of "transfer paper" (gelatine coated) on to each "print-plate" in turn, with due regard to register, condition of moistness, and time that it is allowed to remain on the "print-plate," so that the amount of each dye absorbed by the "transfer paper" may be duly proportioned. The "print-plates" can be used as often as desired, preferably soaking them for a few minutes, each in its proper dye, solution, for each final impression. The resulting prints are finally placed for a minute or two in a solution, the formula of which is not stated, "to increase the pictures' fastness to light" and harden the gelatine, washed for about five minutes, and hung up to dry. The method is also applicable to the preparation of coloured transparencies.

The Royal Photographic Society's Exhibition.—As the Exhibition will be closed before this journal is published, my notes on it must be purely retrospective. It is very satisfactory to find that the practice of recording *changes* by photography is increasing. Not merely recording the phases of rapid motion, as in a series of photographs of a splash, but slower movements, as in the skin moult of a caterpillar, the germination of a grass seed, and the difference caused in an oak tree by fifty years of life. A mere photograph of a living creature is now common-place, unless the animal is rare; to secure attention some characteristic act or attitude must be shown, such as a flock of gulls alighting on the water, a robin eating a worm, or swans flying in anger at their assailant. A set of sixty lantern slides of mediæval baptismal fonts was medalled by the judges, because such work shows considerable sacrifice in the attainment of a specific object, and an object worthy of the sacrifice. A set of lantern slides should always have a definite aim, and if the aim is not obvious it should be stated by the exhibitor. The "pinatype" method of colour photography was demonstrated at the Exhibition.

Paper as used in Photography.—For certain photographic purposes, as in printing processes where the sensitive substance comes into immediate contact with the paper, and is, in a measure, absorbed by it, as in platinum and albumenised silver paper, it is necessary to have paper prepared with great care from pure materials. But when the sensitive material is prepared as an emulsion and applied so as to form a distinct layer, as in the usual printing out papers (P. O. P.), it is desirable to have a smoother and less absorbent surface than that of simple paper. For such purposes the paper receives a preliminary coating or enamelling, as of gelatine hardened with chrome alum, and coloured with a pigment, such as madder lake, or whitened and made more opaque by a white pigment, such as barium sulphate. But in order to get the most perfect impressions from half-tone typographic blocks with their minute and, therefore, shallow etched dots, a still more perfect surface is necessary, and this has led to the introduction of "art papers." From a communication made by Mr. R. W. Sindall to the Society of Chemical Industry and the discussion that followed it, we learn that "art papers" are coated on both sides with some inert mineral substance, such as china clay, barium sulphate and alumina, slaked lime and alum, or precipitated calcium sulphate, which is mixed with a sufficient quantity of an adhesive, such as glue or casein, to hold it together during the printing process without offering a too little absorbent surface to the ink. A coloured pigment is added if desired. Casein is largely used, and as it is insoluble in water, borax or ammonia is added with it to dissolve it, and a little formaline may be added also to get rid of any smell due to incipient decomposition. A heavy "art paper" may contain about 35 per cent. of mineral matter, and the thickness of the original will be increased by some 12 to 15 per cent. by the coatings.

A pure paper must present a very uneven surface, because of the irregularly overlaying fibres. The addition to the pulp of from 5 to 10 per cent. of mineral matter gives a rather smoother surface, and twice this amount gives a marked improvement. A so-called "imitation art paper" is better still and may contain 30 per cent. of mineral matter, though it is not applied as separate coatings as in the best "art papers," but put into the pulp, and brought to the surface to a certain extent by moistening the paper just before it is drawn through the rolls of the calender.

I suppose that an impression in black printer's ink is one of the most permanent kinds of record that can be imagined, but obviously its life is limited by the durability of the substance that it rests on. No doubt there is a tendency to consider that when the paper proper is to be sandwiched between two surfacing layers, it is not necessary to pay very much attention to its quality. But however this may be, it is certain that from a chemical and often from a physical point of view every increase in complexity means an added possibility of disintegration or decomposition. Gelatine (or glue) and casein are particularly susceptible to damp. In "art papers" the impression does not lie on paper at all but upon the surface of the coating. The preparation of a paper that shall satisfy the demands of the printer and at the same time be free from suspicion when regarded from its chemical and physical aspects, remains a very difficult if not an unsolved problem, but it is well to know how we really stand in this matter, that we may not regard only the permanent character of the impressions of our "reproduced" photographs, but also the resisting power to adverse influences of the material on which they are made.

XUM

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, F.R.M.S.

Elementary Photo-micrography.

I HAVE been frequently asked to give some information on photo-micrography which would assist absolute beginners. In endeavouring to act upon the suggestion it must be understood that these notes make no attempt to instruct those who are already more or less expert; absolute ignorance of the whole matter is assumed as a basis. For this reason, also, my remarks will deal with the mere elements of the subject only.

The first question that is invariably asked is whether a regular photo-micrographic camera is necessary. I am afraid that the answer must be in the affirmative. The main reason for this is that absolute rigidity and absence of movement is a *sine qua non*. An ordinary photographic camera could doubtless be fitted to an efficient baseboard by anyone with a mechanical turn, or who is used to carpentry, but the adjustments would be less satisfactory than in a camera made and designed specially for the purpose, whilst the cost of making such a baseboard and adding the necessary fittings and connections would go some way towards the cost of a proper camera. A further reason is that the ordinary camera has insufficient bellows extension. A modern photo-micrographic camera extends to at least thirty inches, and often to very much more. Of course, I have seen photographs taken with an ordinary camera, supported at the necessary height by books of the requisite thickness, but though they seemed to please their authors I am afraid they would not bear ordinary criticism.

The next question is as to the respective advantages of a horizontal and a vertical camera. Dr. Henri Van Heurck, the well-known diatomist, has done nearly all his work with a vertical camera, and there is much to be said in its favour. It is convenient to use; the microscope is in the upright position to which the observer is accustomed, and the adjustments of the microscope are thus more familiar to him, especially because he continues to use the mirror to reflect the light; it is easy to draw the camera-bellows up out of the way, to make most of the adjustments in the ordinary manner, and then to make the final connections, whilst if the camera is of the box type with a large door through which the head can be put to look down the microscope tube the matter is simpler still. Moreover, there are certain cases, such as those in which the object is but temporarily mounted, say, in water or otherwise, in which the microscope must be kept upright. But I think there can be no doubt that the horizontal camera is more satisfactory for all-round work, and, as a result, it is generally used and preferred. Its solid base gives complete rigidity, with, at the same time, every facility for long extension, and it lends itself in particular to the adjustment of illuminant and microscope with their intervening accessories, and more especially to the newer arrangement of optical bench, which has done so much to simplify and co-ordinate the necessary optical adjustments.

I do not propose to speak here of the more elaborate forms of photo-micrographic camera. I am writing for beginners, and, therefore, the simplest camera is the best for them. It must have a solid and steady base, and nicely turned legs must be conspicuous by their absence. The part of the base which supports the microscope must be long enough to hold not only the microscope, but the lamp or other illuminant, and there must be room between the two for condenser, cooling-trough, and stand for coloured screens. All these should be arranged on stands running between parallel guides so as to maintain their alignment with the optic axis of the microscope, whether they are brought forward or pushed back; the stands should be square and not round for the same reason, and there must be means by adjustable bars and by centring screws or otherwise of making the vertical and horizontal adjustments, which will be found to be necessary for each piece of apparatus, and which will prove an important factor in the results. The advantage of the optical bench is now evident. In its simplest form this is merely a heavy triangular iron bar, carefully planed, screwed to the baseboard of the camera, and carrying the light and optical accessories on saddle-shaped bases on its edge. As I have already said, this simplifies matters marvellously, *once the primary adjustments are made*, but a couple of parallel wooden guides make a quite efficient if less convenient substitute.

The camera itself will be raised a few inches higher than the rest of the baseboard, so as to bring its centre level with the centre of the microscope tube. It should extend to at least thirty inches, whilst many extend to sixty inches. The fittings of the camera will be described in due course; here I may just say that the light-tight joint may be nothing more elaborate than a loose sleeve of black velvet attached to the camera front and slipped over the microscope tube and held there in place by a rubber band or ring of elastic. A shutter must, of course, be provided.

The camera and baseboard must all be made of carefully-seasoned mahogany, and the camera must run smoothly and truely in its slides. The dark-slides, &c., should be constructed to take half-plate slides, and should have carriers to take quarter-plate slides as well. I need scarcely say that it is absolutely essential that the plates and the focussing screens must all lie at exactly the same distance from the microscope.

A camera of this sort can be obtained from all the leading opticians from £5 upwards, and both R. & J. Beck, and W. Watson and Sons make, in addition, the optical benches to which I have referred.

Let us now deal with the illuminant. Lamp-light—the light of an ordinary half-inch paraffin microscope lamp—is quite satisfactory for all but the most critical high-power work, but, of course, it needs a relatively long exposure. An inch lamp is better. The incandescent burner is not satisfactory—it gives a good light, but it is spread over too large a surface, and if it is focussed it gives an image of the texture of the mantle. Acetylene is really excellent, the light is good, it is small, and it has high actinic properties. The incandescent electric light is unsatisfactory, because the filament is too obtrusive; the electric arc-lamp is best of all, but, of course, can be indulged in by few who have not the run of a laboratory, and so for all-round work the oxy-hydrogen jet is the best for private workers. It is strong enough, and has sufficient actinic value to make the exposure as short as one need reasonably wish it to be.

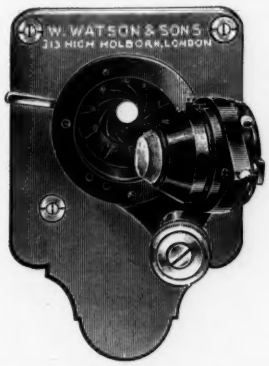
(To be continued.)

The "Ashe-Finlayson" Comparascope.

This instrument is the joint invention of Messrs. Ashe and Finlayson, and its object is to enable an observer to make an exact comparison of two different objects by showing them simultaneously in the same microscope field. The principle is quite simple. What is practically a second microscope is placed horizontally and at right angles to the optic axis of the microscope proper. This second microscope in its simplest form is a horizontal bar, carrying at one end an objective, and at the other end a mirror with universal movements, whilst between the two is a clip serving as a stage and moving by rack and pinion, the position of the objective itself being necessarily fixed. Between the nosepiece and objective of the microscope itself is screwed a tube about an inch long, with a hole at one side to which the auxiliary horizontal apparatus is attached. Inside this aperture is fixed a reflector of tinted glass, worked to a perfect plane on its upper surface, and placed at an angle of 45° to the microscope axis so as to reflect the secondary image upwards to the eyepiece. But in order to allow free passage of the light from the primary objective this reflector does not project more than half-way into the tube. Further, to prevent the overlapping and confusion of images, each set of rays is confined to its own side of the field of view by a removable division plate, which extends from the short tube containing the reflector to within an inch or so of the ocular, the tube being thus divided into semi-cylindrical sections, each of which transmits rays from a different object, and the image of which occupies different segments of the field of view. The inventors have also used a prism instead of the reflector, but have found the latter to be equally efficacious and more simple. The apparatus is made by Messrs. R. and J. Beck, Ltd., of Cornhill. It is quite simple to use.

Watson's Bactil Microscope.

Last month I called attention to a new microscope by Messrs. W. Watson and Sons, which, whilst conforming outwardly and in appearance to the Continental model, retained many of the principles which distinguish the English stand, more especially the lesser fine adjustment. An elaborated form of this microscope, which is to be known as the "Bactil," possesses



one or two additional features that are worth a further note. A mechanical stage can be made either detachable or as an integral part of the stand. In the former case it is very liable to deteriorate in its working parts and to fail in rigidity, and in the latter case it suffers when rough work is being done. In the "Bactil" microscope the horizontal movement works above the stage and is attached to it by thumb-screws so as to be removable, whilst the vertical movement is fixed below the stage, out of harm's way, and is non-removable. Incidentally the long range of movement of the detachable form of mechanical stage is thus attained. The other noticeable feature in this microscope is the fitting, when required, of a coned condenser, carrying the iris diaphragm, which can be readily turned down out of the optic axis if necessary. The arrangement is very similar to that already seen on some Continental stands, notably one of Zeiss', and was first introduced, I believe, on an English stand by Messrs. Ross. The subsidiary iris diaphragm immediately beneath the stage always seems to me, however, somewhat unnecessary.

Notes and Queries.

Major E. F. Beecher, Cheltenham.—I shall be very glad to give you any assistance in my power, but I am afraid I cannot advise you unless I know more definitely the nature of the investigations you wish to make. Histological methods vary greatly according to the end in view, and a fixing or staining agent that would serve one purpose might be quite useless for another. If you will let me know exactly what investigations you wish to carry out, I will try and make some suggestions as to how to set about them.

H. Cliff, Stafford.—The best book dealing with vegetable parasites is Tubeuf's "Diseases of Plants," translated by W. G. Smith, and published by Longmans in 1897. A very elementary and simple little book is M. C. Cooke's "Rust, Smut, Mildew, and Mould; an Introduction to the Study of Microscopic Fungi," published by W. H. Allen and Co., but I am not sure whether this is not now out of print. Second-hand copies are quite easily met with, however, and would not cost more than a few shillings. With regard to insect parasites on plants, you might get Miss Ormerod's "Manual of Injurious Insects." I am afraid none of these will give you much information as to preparing objects for the microscope, but I shall be glad to help you so far as I am able if you get into any difficulty.

A. H. Glaister, Darlington.—As far as my inquiries go, it seems very improbable that *Merulius lacrymans* forms resting-spores of any kind, and indeed it would be contrary to anything that has hitherto been observed with regard to the whole group to which this fungus belongs. The specimens you sent were not sufficient to pronounce an opinion; but it seems doubtful whether the fungus you have been examining is really *Merulius*. Under any circumstances the conditions under which you have made the cultivation have vitiated any trustworthy results, as your observing "swarm-spores" (which might be mycomycetes or infusoria!) shows the culture to be contaminated. I think, therefore, it may be assumed that the spores which you have observed are really those of some other fungus. I am glad you succeeded in resolving *amphipleura pellucida* with oblique illumination, but if mounted in a medium of sufficiently high refractive index it ought to be resolvable with axial illumination with an immersion lens of 1·25 N.A. The condenser should be carefully centred, the edge of the lamp flame focussed rigidly upon the diatom, and then the condenser should be racked up the merest trifle within its focus.

A. Rowland, Newport.—There is an excellent book on *Chironomus*, by Miall and Hammond, published by the Clarendon Press, in 1900, which is a model of what such a book should be and gives explanations as to methods. With regard to the general structure of Bees you had better refer to Dr. Sharp's volume on "Insects," part ii., in the Cambridge Natural History. I am glad you found the note on glycerine mounting helpful. I do not think caoutchouc cement would be satisfactory for glycerine mounts.

[*Communications and Enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for November.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 6.55 and sets at 4.33; on the 30th he rises at 7.44 and sets at 3.53.

The equation of time is a maximum on the third, the Sun being 16m. 20s. before the clock.

Sunspots and prominences are numerous; at the time of writing several fine groups of spots are visible on the solar disc.

The following table gives the position, angle of the Sun's axis, and the heliographic latitude of the centre of the Sun's disc:—

Date.	Axis inclined from N. point.	Centre of disc N. of Sun's Equator.
Nov. 1 ..	24° 41′ E	4° 12′
,, 11 ..	22° 33′ E	3° 7′
,, 21 ..	19° 45′ E	1° 55′
,, 30 ..	16° 57′ E	0° 49′

THE MOON:—

Date.	Phases.	H. M.
Nov. 4 ..	☽ First Quarter	1 39 a.m.
,, 12 ..	○ Full Moon	5 11 a.m.
,, 20 ..	☾ Last Quarter	1 34 a.m.
,, 26 ..	● New Moon	4 47 p.m.
,, 10 ..	Apogee 252,500 miles	0 48 p.m.
,, 25 ..	Perigee 223,000 ,,	4 12 p.m.

OCCULTATIONS.—The following are the brighter occulted stars visible from Greenwich. It will be noticed that the 1st magnitude star Aldebaran is occulted on the 13th, disappearance taking place about 1 hour after moonrise.

Date.	Star's Name.	Mag.	Disappearance.		Reappearance.		Moon's Age.
			Mean Time.	Angle fromN. point.	Mean Time.	Angle fromN point.	
			p.m.		p.m.		d. h.
Nov. 1	29 Sagittarii ..	5·5	6.51	140°	7.29	207°	4 12
,, 4	42 Capricorni ..	5·3	10.55	89°	11.55	232°	7 16
,, 5	σ Aquarii	4·8	10.59	75°	12.4	240°	8 16
,, 7	27 Piscium	5·0	7.30	35°	8.42	273°	10 13
,, 13	α Tauri	1·1	6.35	32°	7.16	299°	16 12
,, 14	115 Tauri	5·4	6.49	75°	7.44	264°	17 12

THE PLANETS.—Mercury (Nov. 1, R.A. 15h 12m; Dec. S. 19° 7′. Nov. 30, R.A. 17h 55m; Dec. S. 25° 33′) is an evening star in Scorpio at greatest easterly elongation on the 27th, when he sets at 5 p.m. This elongation is very unfavourable on account of the great southerly declination of the planet.

Venus (Nov. 1, R.A. 12h 51m; Dec. S. 3° 44′. Nov. 30, R.A. 15h 9m; Dec. S. 16° 26′) is a morning star on the confines of Virgo and Libra. The planet is not well placed for observation.

Mars (Nov. 1, R.A. 19h 17m; Dec. S. 24° 6′. Nov. 30, R.A. 20h 49m; Dec. S. 19° 19′) is visible in the S.W. for a few hours after sunset, but as the apparent diameter of the planet is now small, it is not a very suitable object for observation in small telescopes.

Jupiter (Nov. 1. R.A. 4h 10m; Dec. N. 20° 0′. Nov. 30, R.A. 3h 55m; Dec. N. 19° 19′) is describing a retrograde path between Aldebaran and the Pleiades. The planet is very favourably placed for observation, being in opposition to the Sun on the 24th, and is the most conspicuous object in the evening sky looking S.E. The equatorial diameter of the planet on the 25th is 49″·4, whilst the polar diameter is 3″·2 less. The following table gives the satellite phenomena visible in this country, before midnight:—

Date	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P M.'s, H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
Nov				Nov				Nov			
1	I.	Ec. D.	9 7	10	I.	Oc. R.	8 1	23	II.	Sh. I.	9 7
	I.	Oc. R.	11 51	14	III.	Oc. R.	7 41		II.	Tr. I.	9 10
2	I.	Tr. I.	6 57	16	II.	Sh. I.	6 29		II.	Sh. E.	11 42
	I.	Sh. E.	8 36		II.	Tr. I.	6 55		II.	Tr. E.	11 42
	I.	Tr. E.	9 8		II.	Sh. E.	9 4	24	I.	Oc. D.	9 17
3	III.	Sh. I.	11 15		II.	Tr. E.	9 26		I.	Oc. R.	11 29
7	II.	Ec. D.	9 31		I.	Sh. I.	10 11	25	II.	Ec. R.	6 28
8	I.	Ec. D.	11 1		I.	Tr. I.	10 24		I.	Tr. I.	6 32
9	II.	Sh. E.	6 26	17	I.	Ec. D.	7 25		I.	Sh. I.	6 34
	II.	Tr. E.	7 11		I.	Oc. R.	9 45		I.	Tr. E.	8 44
	I.	Sh. I.	8 17	18	I.	Sh. E.	6 53		I.	Sh. E.	8 47
	I.	Tr. I.	8 41		I.	Tr. E.	7 1	26	I.	Ec. R.	5 57
	I.	Sh. E.	10 30	21	III.	Ec. D.	9 11	30	II.	Tr. I.	11 25
	I.	Tr. E.	10 52		III.	Oc. R.	10 57		II.	Sh. I.	11 45

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its re-appearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress.

Saturn (Nov. 1, R. A. 21h 56m; Dec. S. 14° 19′. Nov. 30, R. A. 21h 59m; Dec. S. 14° 0′) is best observed immediately after sunset, being due south at 6.20 p.m. on the 15th. Telescopically, the planet with his rings is a beautiful object, and on account of his low altitude the position for observation is a most comfortable one. The apparent diameter of the ball is 16″·0, whilst the major and minor axes of the outer ring are 39″·6 and 7″·9 respectively, the ring appearing well open.

Uranus (Nov. 1, R. A. 18h 6m; Dec. S. 23° 42′) sets shortly after the sun, and hence is not available for observation.

Neptune (Nov. 1, R. A. 6h 44m; Dec. N. 22° 5′) rises about 7 p.m. near the middle of the month, and is due south about 3 a.m. The planet is situated in Gemini in a region rich in small stars, thus making identification somewhat difficult in small telescopes.

METEORS:—

The principal showers of meteors during the month are the Leonids and Andromedids; the Moon will somewhat interfere with observation of the former, but the latter shower occurs in the Moon's last quarter; moreover, the Andromedids may be numerous this year.

Date.	Radiant. R.A.	Radiant. Dec.	Characteristics.
Nov. 14-16	150°	+22°	Swift, streaks. (GREAT LEONID shower)
Nov. 17-23	25°	+43°	Very slow; trains. (GREAT ANDROMEDID shower)

Minima of Algol may be observed on the 13th at 9.7 p.m., and 16th at 5.56 p.m.

TELESCOPIC OBJECTS:—

Double Stars:—η Cassiopeiæ 0h 43m, N. 57° 17′, mags. 3½, 7½; separation 5″·7. Binary star.

λ Arietis 1h 52m, N. 23°·6′, mags. 4, 8; separation 37″. Components white and blue; easy with power 20.

η Persei 2h 44m, N. 55°·28′; mags. 4, 8; separation 28″. The brighter component is orange, the other blue. There are also several other fainter stars very near.

XUM

SUPPLEMENT.

[Although it has not been usual to include fiction within the pages of "KNOWLEDGE," the following discourse, which is but a tale built around a new and possibly important scientific proposition, seems to be one not inappropriate to the contents of a scientific journal.—ED.]

London's Transformation.

A Suggestive Sketch of Days to Come.

By TEMS DYVIRTA.

CHAPTER I.

INTRODUCTORY.

London! That vast city sheltering so many millions of human beings, a far greater population than any town at any time has contained. London, that province of brick and mortar covering an area more extensive than that of any other two cities. London, the great capital of the British Empire, which is the largest, wealthiest, and most powerful nation the world has ever seen. The central point of the land surface of the globe, the link 'twixt the old world and the new. Truly the "hub of the universe," if there be one.

A recent writer affirms that "Within the next ten years there will have been added to London a greater number of costly and important new buildings than in any similar period since the re-building of the City after the great fire of 1666." An extra half million of inhabitants will have to be housed, besides those who have been turned out to make way for the great Government and other buildings already planned.

Can the life of London last? With an ever extending Empire, growing richer day by day, to provide for; with trade and revenue increasing in proportion; with a population doubling in half a century, the heart which gives it life, the brain which gives it power, the counting-house of its central management cannot extend its bounds without unwieldiness, except by the adoption of some sweeping measure, such as the Tushian scheme.

But, fortunately, so beneficial a design, effectually neutralising present overcrowding, would extend London's life.

Yet this vast collection of buildings is but a sorry city. It is, whatever may be said to the contrary, but a collection of towns. There is no centre, no one High Street from which others radiate, no district to contain all the chief buildings. It is an animal without a backbone, a tree without a stem. The streets are narrow and overcrowded. The main arteries are congested with traffic, and owing to lack of being systematically laid down, have to be continually "up" whenever the drains and wires buried under them receive attention.

Good healthy house accommodation, too, is wanted, the slums need re-building, but they will not be rebuilt so long as land is so scarce.

Moreover, it is a dirty place and is cursed with a chronic fog, which chokes the lungs of its dwellers, which darkens and saddens the homes it contains, and which is said to cost at times from £50,000 to £100,000 a day in extra illuminants and in other ways. And this fog is attributed to the murky river and its damp bed, which traverses the great city.

In one of the latest books on Meteorology* we read "In a city like London or Glasgow, where a great river, fed by warm streams of water from gigantic works, passes through its centre, fogs can never be entirely obliterated."

A river running through a populous town cannot be healthy. All the filth is washed down into the channel and becomes collected there and its offensiveness disseminated.

And this same river, too, not properly kept in hand, has a way now and again of getting above itself and flooding the low-lying streets. Everyone will remember (or, at all events, those that were in London at the time now being referred to) the awful catastrophe that occurred in the Underground railway about this time. It may be as well to recall the main facts. Some drainage operations were being executed on the Embankment, when an unusually high tide swept away some stones in the Embankment wall, which had probably long been slightly displaced. The water rushed through and flooded the excavation, and, washing away the earth around, at last burst in the brickwork of the tunnel of the Underground railway. This had most appalling consequences. Several trains were stopped. The water rapidly rose in height, some of the passengers clambered on to the tops of the carriages, while others waded and swam to the nearest stations. But it was all in vain, for the tide was at such a height that the level of the water reached far above the platforms, and only a very few persons succeeded in getting up the steps. And, what was worse, the raging torrent rushed along the line for miles, and soon found its way into the "tube" railways, where again whole train-loads perished. It proved to be the most terrible catastrophe that ever occurred in London.

Then if we go further afield it is surprising to find that poor little ditch, the Thames, whilst greatly prized

* By Dr. J. G. McPherson.

and justly celebrated as a recreation ground for boat-loving Englishmen, yet above bridge so narrow and crowded, below so dirty and overrun with shipping.

And even here we are threatened with the possibility of further disasters. Has anyone calculated what would be the consequence of the river, say at Eton, rising three feet higher than it has done? Owing to the gradual contraction of the banks and wharfs in London preventing a free flow, a sudden great rise, such as might be caused by an abnormally heavy rain-storm, would certainly have most disastrous consequences on the towns and villages of the valley of the Thames, and many thousands of pounds' worth of damage would certainly be done, and there would be great probability of a serious loss of life.

One more matter regarding this London and its river. What if an invading army were to land in England and advance against it? Military geniuses are full of their schemes for erecting forts on the hill tops of the North Downs, but recent authorities tell us that a river is the most efficient barrier, when properly guarded, to the progress of an invading force. Yet where is the desired river? The Thames, as it is, does us no good in the defence of London.

But enough of this commentory on the wonders and on the ills of London, and the Thames, and let us hear how a great change came about at a period not very clearly located in the annals of the century.

CHAPTER II.

CORNELIUS J. TUSH.

In one of the busiest corners of this busy city a small group of men might have been observed. The one on whom our attention must be fixed is a middle-aged, rather short, clean-shaven man, with clear-cut features, typical of shrewdness, if not cunning. His clothes have the appearance of being well cut, and even show signs of dandyism and a display of wealth. Yet on closer examination they will be seen to be old and well worn, and should have been discarded ere this by a wealthy beau. Note, too, the face. Is there not a shade of disappointment? Are there not evident traces of failure and mental suffering? And who are his companions? Just the ordinary typical City men, but evidently from their manner they hold our friend in reverential awe. Having finished their confabulation, they respectfully take off their hats and pass away. "Bateson!" called this man to one of the group, who at once turned back, "Remember! don't mention my arrival in this country till the appointed day. Meanwhile I reckon you know what to do." "Very good, Mr. Tush," responded the other, "trust me." So they parted, and Mr. Tush wended his way back right through the City, and on, sadly and pensively, to the south of the river. Still onward he goes towards Lambeth, up one small street and down another, picking his way in the mud (for his delicately-made boots are worn and broken out in places). There is much mud here, too, for an exceptionally high tide has caused the river to overflow, and for a day the streets have been almost impassable. He turns up the steps of an ordinary-looking little house over the front door of which is a fanlight and a card inscribed with the word "Apartments." Our friend knocks on the rusty knocker, and a stout old female, with sleeves rolled up and a dirty apron covering her portly front, opens the door. A smile beams on her fat face as she recognises the visitor, and taking from a small shelf two or three letters, she hands them to him. The letters bear the inscription "Cornelius J. Tush, Esq.," followed by so many addresses scratched out and re-directions put in that the poor postman must have offered a silent deprecation as he endeavoured to decipher the desired destination of the missives.

Cornelius J. Tush! Can this be the great American millionaire? He with the world-wide reputation for vast wealth and keen sagacity in all commercial enterprises? He, the clever son of the great "Button King," Abraham Tush? Aye, verily! but what a come-down. His history of the last few weeks is easily written. He had been living in domestic happiness and luxury in his home near Philadelphia, when affairs began to go wrong. His great scheme of the Grand Central Railway had failed. The Pacific Canal was not yet near completion, although absorbing millions of his invested dollars. The inventor he had set to work to experiment on a large machine, which was to have revolutionised the world's methods of travel, had at last to acknowledge that he was completely baffled after expending some 500,000 dollars in experiments. One thing after another had gone wrong, and Cornelius had to own to himself that he was a ruined man.

Frantically he endeavoured to struggle against the rising tide. All kinds of wild schemes did he propose to his erstwhile disciples, but all New York had become suspicious, truth will leak out; and though no one, of course, knew exactly where Cornelius' money lay, or in what quantities, dark rumours began to spread abroad, and people shook their heads and said to themselves, "Avoid Tush." It was, indeed, a time to make a man think; but Cornelius was a determined character, and the more hopelessly he found himself sinking in the mud, the bolder and more pretentious were his schemes. He thought of his father's methods, which were to go in for that which will sell by the million, never mind what it is or how small the article, so long as it sells by millions. "Now look at buttons," he used to say, "why, every man on the face of the globe, or no, every *civilised* man, has a dozen on each of his trousers alone, and, then, look how easily they are lost!" Why can't one think of something new, something that everyone needs, invent a boot sole that won't wear out, or a new food that everyone would eat?

Well! New York was played out, and with it all commercial America. But the name of Tush was well-known in England, and here, possibly, the sinister rumours had not filtered through. He would see if a 'cute Yankee could not "bluff" the Britishers. No sooner thought of than the plan was put into execution, and Cornelius bade a touching farewell to his young wife, the beautiful Alma Dalvine, and his little only daughter, Libertia, and took the boat to seek his fortune on the far side of the herring pond.

Arrived in London, Cornelius set to work to carefully reconnoitre his ground. He had managed to bring away, as almost the last remnants of his great fortune, what most people would call a good round sum of ready money, but this would require to be very carefully expended, and he had determined to be as economical as possible so as to have the more when the time came for definite action.

So for the first week he "lay low" in his miserable lodgings in Lambeth, deciding that when all was ready he could "cut a dash and set things humming."

But first of all it had to be noised abroad that the

great Cornelius Tush was coming over to London with a view to investing some of his millions in whatever took his fancy. He proposed, then, getting into a few big (if risky) undertakings, and selling out his shares before paying for them. His was a name to conjure with and he a good prestidigitateur. Bateson, a man with a great reputation for shrewdness in business, though for nothing else, was acting as his chief agent in the matter. London happened to be in the right state, too. An air of speculation was rife in the City. Things were prosperous, and new schemes were finding favour.

Having then got the news about that he was shortly to arrive, the great man was to appear upon the scene; not, of course, as the sordid, broken-down failure, but as the American Crœsus, with so much money that he didn't know what to do with it all. Then he would make a great display of wealth so as to bear out his reputation, and thus would he take the place by storm, and become again, in fact, a multi-millionaire.

CHAPTER III.

THE DINNER.

This much, then, had been done, and Cornelius was now about to issue forth from his chrysalis state into the splendid butterfly. A mass of correspondence had passed between the Tush agents and all sorts and conditions of people organising new ventures. Many of the schemes suggested were, of course, absurd; many more may have been sound enough, but they were not of the sort required; that is, they were not the gigantic undertakings worthy of the notice of such a magnate. Sifted down, there were some ten or a dozen concerns worth consideration.

There was Singman's World Emporium Syndicate for the conversion of his already large business in Islington into a colossal City establishment.

Then Lord Henry FitzEdmund, that shaky old outcast of the aristocracy, had got together a small syndicate of nobodies with high-sounding names, in the hope of building a large new Theatre, a Palace of Varieties, such as would dwarf all the old-established places of entertainment.

The European Hotel Company, under the management of the well-known M. Jean Rideau, wished to open a grand new hotel in some central situation.

There was the good old Lord Whittingbourne, with his proposal for housing the poor; not suggestive of much money-making, but a huge scheme which would cause millions to pass. Besides all these were a new tramway company, a great building syndicate, and many more projects which need not be recounted.

It was difficult, indeed, to see how it was possible for Tush to set them all going. Most of them required capital, and he had none. But, then, his name might secure others who *had;* anyhow, they were all big things, and something might be got out of them. Tush always avoided involving himself by talking matters over too minutely, but preferred (having heard or read all details of the scheme) to leave matters in such a vague, uncertain state, that no one quite understood how much or how little he had become identified with the project.

He was now to meet the various promoters. The best way to do this, he decided, was to ask them each to dinner "to talk it over." If they came and did themselves well, they would return thinking all *was* well, even though nothing whatever had been definitely settled. So all the principals were invited to a great banquet (called a "quiet dinner") at the Savile Hotel, where the millionaire had now taken up his quarters. How all this was to be paid for Tush alone knew, but it was not difficult for a man with such a name and fame to get together a few thousand pounds. Accordingly, one day, the butterfly burst forth from the chrysalis, and even mine host of the Savile, accustomed as he was to wealthy and particular customers, was aghast at the sumptuousness of living displayed. Wherever he went Tush was most lavish with his money. Cabmen were always paid (before strangers) in gold. Waiters received handsome gratuities. Beggars had sovereigns flung to them. Everything was done to display his wealth. The visitors that called had always to be supplied with the best champagne and choicest cigars. The finest suite of rooms in the hotel had to be reserved, three or four servants were specially told off solely to wait on the great man.

Then came the dinner. Each item was of the choicest and the costliest. No money was to be spared in serving the most magnificent repast that could be procured. A large private dining-room was engaged for the occasion. Superb table decorations were tastily arranged on the groaning board. Menus, engraved on solid silver in the form of a suitable souvenir, were supplied for each guest to take away with him. It almost got to the stage of the proverbial city feasts, where a bank-note was placed under every plate (though, in reality, *these* would not have been so easy to supply, credit for such not being so readily obtainable).

The guests duly arrived and were ushered into the presence of their munificent host. A few well-chosen words greeted each of the patrons of progress, and shortly the distinguished company trooped into the great dining-room, resplendent with its dazzling display of sumptuousness and wealth. So the brilliant banquet commenced, Lord Whittingbourne, on Tush's right hand, eagerly discussed his philanthropic scheme, which, as he pointed out, required more capital than he had originally estimated for, since he had come to the conclusion that a good *central* site for the building was most essential, as the working man ought, without doubt, to be near his work. On the other side the Chairman of the European Hotel Company quizzingly referred to the dinner that *he* would give in return when their great London Hostelry should be opened, while Lord Henry, with a satanic grin, wished his grand palace of entertainment was ready for them all to repair to as a fitting *finale* to the programme. The various schemes were each privately referred to during the course of the evening, but little was promised. "Well, we must see what we can do," was the usual vague yet encouraging reply of Cornelius.

The party finally broke up in the best of spirits. Each of the guests considered that *he*, and he alone, had the ear of the all-powerful Tush, looking upon the others as mere guests with no special object to achieve. They all rolled off in their hansoms, cigar in mouth, to instil hope into their respective *confrères* awaiting them at their clubs.

Thus passed off one of the most notable dinners of the day. Ostensibly full of promise of great things, yet, in reality, it might have been barren of results had not the mind of Tush happened to hit upon that great idea which proved so far-reaching in its development.

XUM

CHAPTER IV.

THE GREAT IDEA.

Cornelius, with heavily-burdened mind, strolled out alone on to the Embankment. Revolving over in his mind the various proposals, he noted that there was one peculiar feature which happened to be common to nearly all of them, which was that they had as their main requirement a large plot of land centrally situated in London. This was all very well, but the place was altogether too crowded as it was. Cornelius was sad, sad because he was baffled. Yet he felt confidence in himself. Past experience told him that expedients and remedies always came eventually to his ever-ready brain; so he lived in hope. He sauntered on along the broad Embankment with its plane trees and dolphin lamps. Many a miserable creature did he pass, skulking along or huddled on a seat. These people did not possess such confidence as his. It is true they found bread was wanting, and lived in hopes of its coming spontaneously to their mouths, rather than that ideas should come to their minds. They thought of present wants, Cornelius only looked to the future. With prospects of impending happiness and plenty we can easily struggle through troubles and hard times, but when there are no prospects, what is one to do? "Turn your mind over," mused Cornelius, "plough it up like a cornfield, put in the seeds, the ideas, the data, and a crop will surely grow." Well, what were the seeds to be? What was required? If only an acre of City land could drop down from heaven and plant itself in its proper place, then all would be well, that is, *if* Cornelius owned it. He wandered on towards that great beacon shining in the sky; that outward and visible sign of the inward and spiritual brain of the Empire, the Clock Tower at Westminster. Here he met the busy, hurrying stream of transpontines making their way homeward, and, carried as it were by the stream, he, too, moved on to the great wide bridge. Possibly because his mind was absorbed, his instinct was leading him to his late home. At the centre of the bridge he stopped and paused to gaze upon the sight presented looking down the river towards the City. The thousands of lights of all colours! The gas lamps, the blue electric lights, the red and green railway lamps, the lurid glow of the illuminated streets beyond, and then their reflections in the great black, surging stream below. How weird that looked! How many people at the lowest depths of despair had there gazed and then thrown their vile bodies into the muddy swirl to end for ever their earthly miseries! Cornelius thought of this. Had he, too, come to that pass? Should he, too, find his death in the gloomy depths, or could he there find the first shooting blade for his mental cornfield? "Ah!" he thought as he surveyed that silent, vast expanse of emptiness devoid of people or traffic, surrounded by crowded houses, yet itself nothing but expanse, a layer of waters stretching so far away to the distant lights lining the south bank, "If that were only dry land!"

The seed has sprouted! The merest speck of green, but there was a speck, and might that not become a blade? "Only *land!*" Could it not be utilised as such? Could it not be *made* land? Here he was standing on solid enough ground with the water flowing beneath him. Could it not *all* be bridged over and houses built on the bridge, even as they were in the days of ancient London Bridge? The river would then be but a huge sewer. What size of pipes would it require to carry that great flow of water? But then, might not the pipes be distributed about under the great City; or could not an enormous tunnel be constructed, deep down, below the level of the "twopenny tubes"? Really, there seemed promise in all this. The Thames, caged and tamed, and made to go where man may will! Then why not divert its course, lead it out into the country, and leave all that great area of City property dry, and available for building? Cornelius fairly gasped. It was a huge idea that had struck his brain. An idea that must be at once carefully fostered and matured.

For some time he remained leaning on the parapet deeply engrossed in his thoughts, oblivious to the human stream that flowed steadily past him. Then suddenly he stood up and looked around. "Yes," he said, almost audibly, "it will be the biggest thing ever heard of. My fortune is made." Then, after eyeing carefully first one end, then the other of the bridge, he briskly walked back, and having aligned himself with the Embankment wall, started to carefully pace the length of the bridge. "Over 300 yards! Then every fifteen yards of river will give us nearly an acre of ground. Why, there must be fully 300 acres between this and the Tower! Here is a site for Singman's Emporium, for FitzEdmund's Theatre, and for all the others put together. I can take on the whole lot, come what may. I'll write to them *all* to-morrow, and say I can arrange for suitable sites *if* they will pay the price and not require immediate possession."

But what was to be the price? It would require a big calculation. Undoubtedly the most practicable scheme was that of deviating the course of the river to flow through country fields instead of among crowded houses. There would then be a huge canal to construct. But though, perhaps, wider, it need not be one-tenth the length of the Suez Canal, and, probably, not so deep, unless, indeed, it were found desirable to make a *ship* canal right round London. The land over which the deviation must be cut would have to be bought. This would require a large sum, since it would involve the purchase of much house property. And whereabouts was it to be? Which would be the best course for the new river to flow to the sea? Where was the lowest lying country, or what would be the size of cuttings through the hills?

Then what was to be done with the reclaimed land, which would be wide enough for, perhaps, four parallel streets? The bed of the river could be filled in, to some extent at least, with the earth got from the cuttings.

There is, too, the river traffic to be considered. All those barges and steamers must go somewhere, else enormous compensation would be demanded. But they don't take up all the river, and a narrow portion could be left as a canal for the water-borne trade of London, while communication between the upper and lower reaches of the river could be continued on the deviation.

Railways, drains, electric wires, and such like could be laid along the bed of the river and built over.

Yes, all this would truly require enormous funds, still it had its merits, and a good thing can always be run if it is properly worked. The capital is there, somewhere. It only needs to be got hold of.

Evidently the way to set about it is to form a huge company. Advertise enough, make the most of all the various advantages to be gained, and all the different ways in which money is to be made out of it (and mention none of the difficulties or possibilities of failure), and the capital will be forthcoming.

Thus did Cornelius conceive his crop sprouting up, and visions of the harvest he would some day reap haunted him throughout the night.

(To be continued.)